POWER PLANT ENGINEERING

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The New Gulbransen-Dickinson Plant

CHICAGO PLAYER PIANO MANUFACTURER TURNS TO ISOLATED PLANT SERVICE TO SECURE GREATER ECONOMY AND RELIABILITY OF SERVICE; WOOD WASTE UTILIZED AS FUEL

ENERGY for the operation of the machines and the lighting of the buildings comprising the modern industrial plant may be obtained from the lines of a local public service corporation, from an isolated power house forming an integral part of the plant or as is now frequently done by a combination of the services rendered by these two sources. Whether to employ central station service exclusively, to rely entirely upon an isolated plant or to make provisions for the purchase of electric energy from the former and to utilize the latter only for such service as may be required for the heating of buildings and in manufacturing processes, is a problem of engineering nature which of necessity can be solved only after a thorough investigation and study of local conditions. To prescribe central station service arbitrarily may prove as foolhardy as insisting upon the installation of an isolated plant where electric energy only is required and no demand for steam for heating or manufacturing purposes exists. That each of these has its particular field has again been demonstrated in the case of the Gulbransen-Dickinson Co., Chicago, manufacturers of player pianos, who recently, because of the diverse requirements of that industry, found it more economical and more satisfactory to install a private plant for the generation of electric energy to operate their factory motors and light their buildings and grounds, to produce that steam so necessary for heating, for the drying of lumber and other production processes and to furnish air for the operation of pneumatic tools and the testing of the player mechanisms.

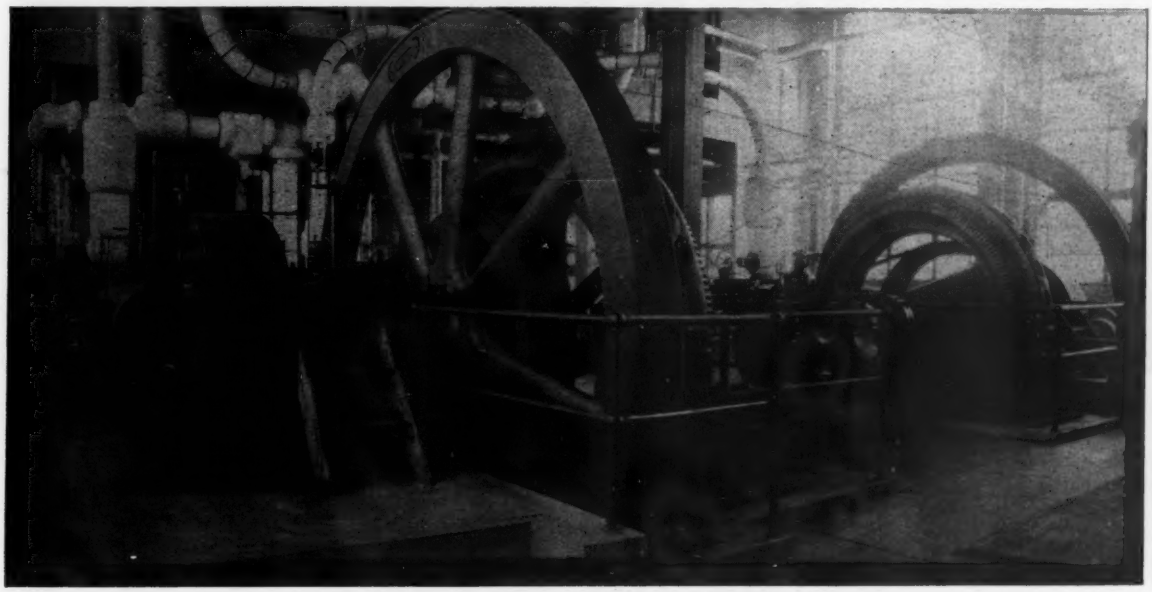


FIG. 1. GENERAL VIEW OF ENGINE ROOM

Previous to last November, all of the electric energy used at this factory was purchased from the local public service company while at the same time a complete steam generating plant was maintained, an arrangement which in this particular instance proved not only exceedingly uneconomical but wasteful as well.

When, however, plans were drawn for the new six-story factory building now located at the northwest corner of North Kedzie and West Chicago Avenues, a modern and most completely equipped power plant was

embodied. This, which was placed in operation on about November first of last year, occupies a plot of ground approximately 58 by 120 ft. on North Sawyer Ave. directly south of the tracks of the Chicago, Milwaukee & St. Paul Ry. It is of brick, concrete and steel construction and consists essentially of a boiler room and an engine room, the general arrangement being such as is indicated in Fig. 5. A mezzanine floor extending over the engine room is utilized to care for some of the equipment such as a surge tank, an air receiver, an after cooler, a hot water heater and an expansion tank for the reception of the exhaust steam from the various prime movers and auxiliaries; here are also found toilets and shower baths for the plant operating staff.

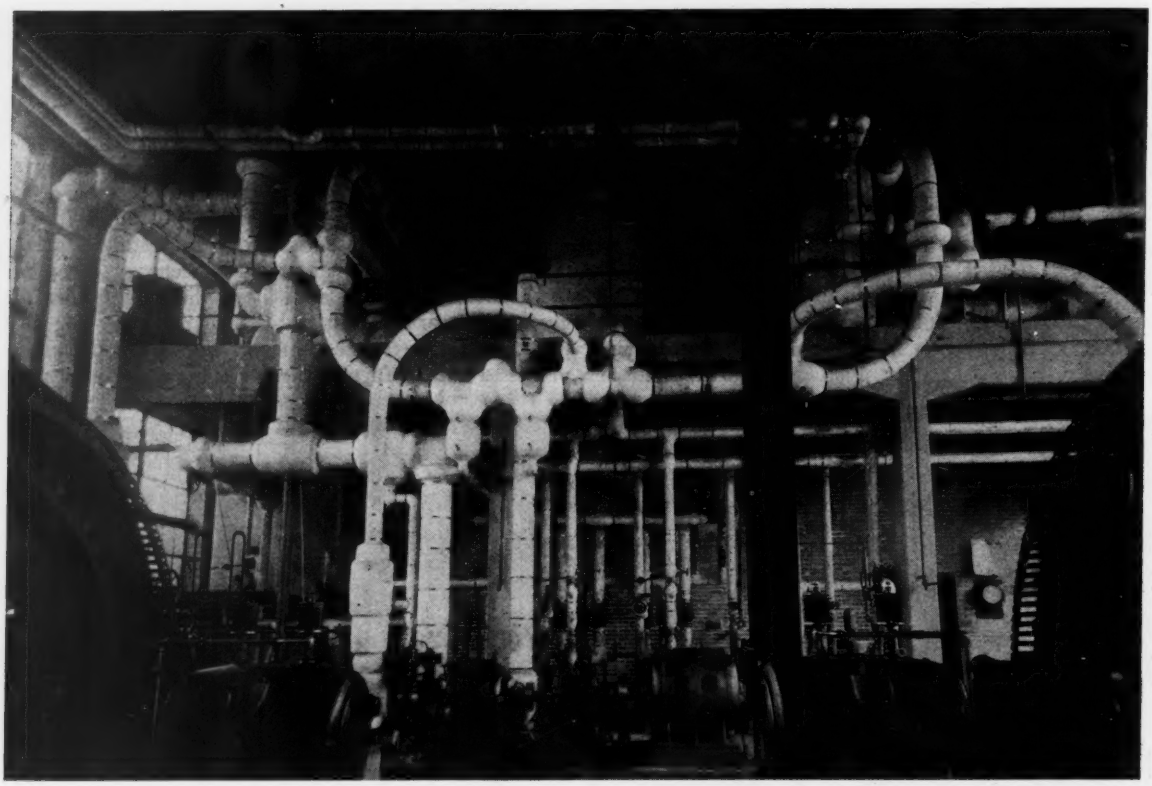


FIG. 2. SHOWING THE TURBO-GENERATOR SET AND SOME OF THE MAIN PIPING

Fuel Supply

Where formerly great amounts of wood refuse were sold at ridiculously low prices and even at times disposed of for the cartage charges, this is now entirely utilized in the production of power. Two of the three boilers installed are equipped with dutch oven furnaces for the burning of this fuel while the third is arranged to use coal, this being fed by means of a chain grate stoker. The wood waste coming from the factory is received by a cyclone placed on the roof of the boiler room and from this is delivered to the furnaces through chutes provided for the purpose. That not required for immediate consumption is discharged into a concrete shavings storage bin located as shown in Fig. 5 directly in front of the boilers and used whenever the factory supply may be somewhat limited or insufficient to meet the demands of the furnaces. To avoid packing of the shavings in this bin and to facilitate their ready removal, an agitator consisting of a crank shaft equipped with numerous paddles extending throughout the length of the bin and driven by a 2-hp. motor has been provided. The shavings are taken from this bin and delivered to the cyclone by a blower placed at the bottom of the bin and operated by a 10-hp. motor. They are then delivered to the furnace in the regular manner.

Due to the fact that but little coal is used, no provision has been made for the automatic handling of this fuel. It is dumped from the railroad cars run on a private siding and wheeled into the boiler room.

Ashes and other furnace refuse are handled by means of a steam jet conveyor installed directly in front of the boilers.

Steam Generation and Distribution

Each of the three water-tube boilers referred to above has a nominal rating of 325 hp. and is ordinarily operated at pressures ranging from 125 to 135 lb. gage depending upon load requirements. Eight-inch leads fitted with automatic stop and non-return valves deliver the steam to a 12-in. main header carried along the tops of the boilers which in turn connects with and feeds an 8-in. circulating main extending into the engine room and a 6-in. auxiliary header for supplying the pumps, etc. This auxiliary header also connects with a 48-in. by 12-ft. expansion tank employed to serve as a source for low-pressure steam used for heating, lum-

ber drying and other manufacturing processes, a double connection, one carrying a 4-in. and the other a 2½-in. pressure-reducing valve having been provided for this purpose.

An independent 3½-in. line tied in with the auxiliary header serves the fire pump while the air compressors, as also the various boiler feed, house service and vacuum (heating system) pumps are fed through the medium of a 4-in. line. Six-inch leads each equipped with a 7-in. steam separator join each of the main engine cylinders to the circulating headers; the turbo-generating set is fed through a 4-in. line and is likewise fitted with a separator.

The general layout and arrangement of the complete piping system is well shown in Figs. 2 and 5, and as may be seen from a study of Fig. 5, the scheme em-

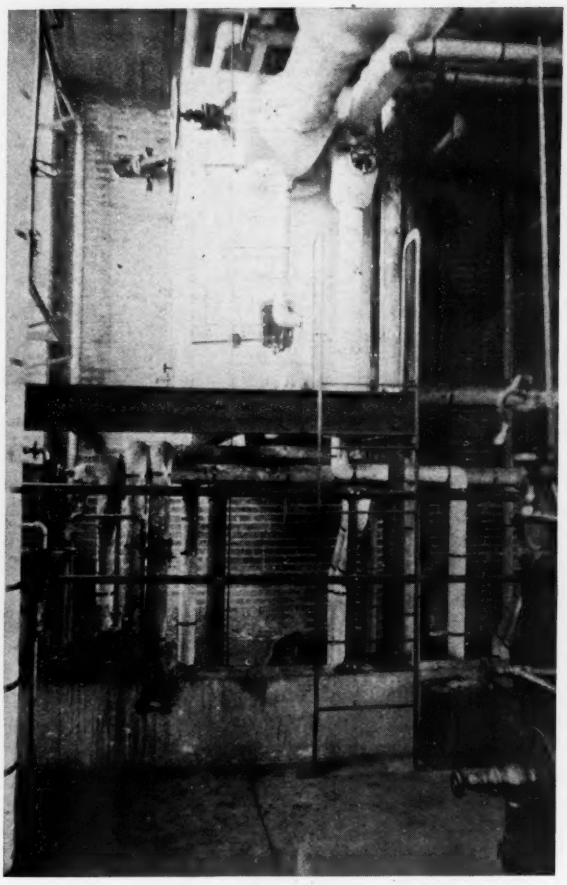


FIG. 3. THE FEED-WATER HEATER INSTALLED IN ENGINE ROOM

ployed throughout the installation is such as will insure a maximum degree of flexibility of operation, high economy and continuity of service.

Handling the Exhaust

As is the case in many industries, the production of electric energy at the plant of the Gulbransen-Dickinson Co. is in reality a by-product. Low-pressure steam is required for various purposes and as a consequence the means provided for the handling of the exhaust steam are somewhat unusual and unique. That coming from each of the main engine-driven generating units is carried through 8-in. lines, laid in trenches, which, after joining with a like-sized connection coming from the turbo set by means of a 12 by 12 by 8-in. tee, tie in with a 12-in. riser extending to the roof of the engine room, at which point it is terminated with an exhaust head. This riser is in addition equipped with a 12-in. back-pressure valve and two branch connections, one 10-in.

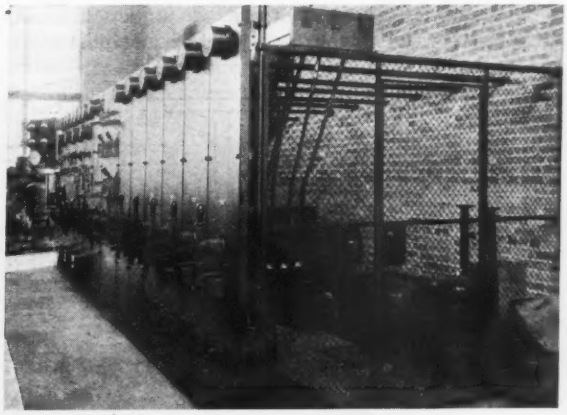


FIG. 4. GENERATORS, AUXILIARIES AND LIGHT AND POWER CIRCUITS AS CONTROLLED FROM THIS BOARD

to the feed-water heater shown in Fig. 3, and a 12-in. to the 48-in. by 12-ft. expansion tank on the mezzanine floor and from which the low-pressure steam is distributed. Augmenting this expansion tank supply is a 10-in. high-pressure line by means of which a constant flow of low-pressure steam is assured regardless of the number of main or auxiliary units in operation. The kilns are served through a 10-in. connection while the heating system and other manufacturing processes are cared for by a 16-in. line carried underground to various distribution points.

Water Supply

All of the water for boiler makeup, domestic service and fire protection purposes is taken from the city mains and as at times the amount required is of such volume as would work havoc with the outside service were this pumped directly, a surge tank into which the water from the city lines is allowed to flow has been installed on the mezzanine floor. Augmenting this, particularly for fire protection purposes, is a 50,000-gal. tank on roof of the new factory building at the corner of North Kedzie and West Chicago Aves. With this arrangement, any unusual demand for water may be well met.

Practically all of the pumping equipment is found in the engine room. Directly under the balcony are the two house service pumps each a 7½ by 8½ by 10-in. pump, also of the duplex type used for boiler feed purposes and in a pit below the floor two 10×16×18-in. and one 8×10×12-in. simplex vacuum pumps used for handling the hot water from the floating system.

There are three hot-water return mains, one 3½ in., one 4 in. and the other 5 in. in diameter. These, together with a 2-in. drain from the feed-water heater

and the expansion tank, empty into a 6-in. header which in turn serves the vacuum pump suctions. The discharge header of these units is 5 in. in diameter and ties in with a riser serving a 36 by 72-in. separating tank which in turn serves the boiler feed pumps either directly or through the feed-water heater shown in Fig. 3, the scheme of piping and valving employed being such as to allow cutting out the feed-water heater for cleaning or repairs without in any way impairing the continuous operation of the plant. Each or both of the boiler-feed pumps—which are under automatic control—may be made to serve either one or two, or

and other electrical apparatus and the testing of the mechanism of player pianos. The equipment provided to supply this air consists of two 7 by 9 by 8-in. steam-driven compressors, an after cooler and a 48-in. by 10-ft. receiving tank which serves two 3-in. supply lines leading to the various factory buildings.

Electric Generation, Distribution and Utilization

Electric drive is employed throughout the shops, the energy for which, together with that used for the lighting of the works, is secured exclusively from this power plant. No outside service has been provided for.

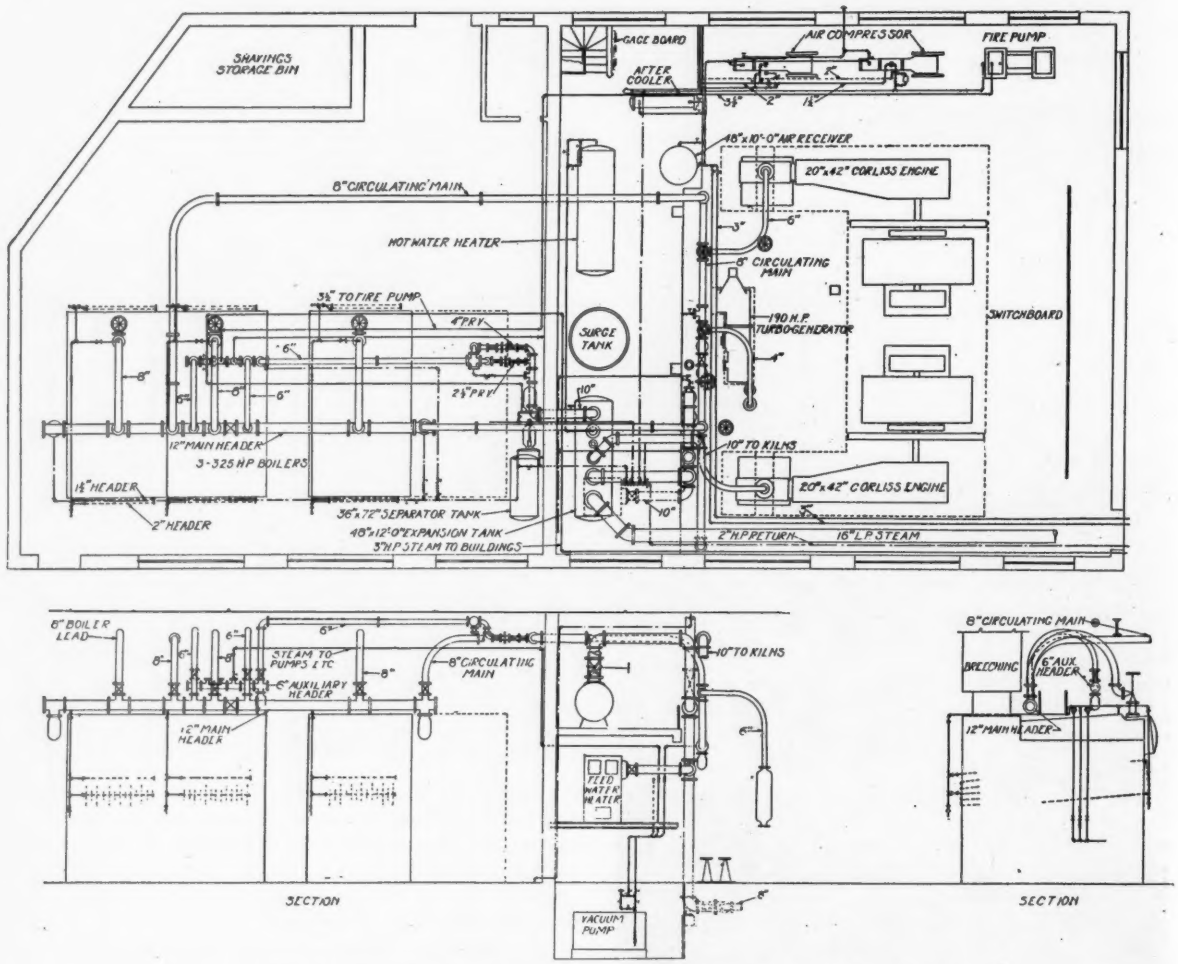


FIG. 5. PLAN OF THE NEW GULBRANSEN-DICKINSON POWER HOUSE

both, 4-in. mains carried into the boiler room and along the boiler tops. Regulation of flow to the individual steam generating units is under manual control.

The boiler blowoff header is also 4 in. in diameter and connects with a 48-in. by 5-ft. cast-iron blowoff basin located in the boiler room and fitted with a 6-in. vapor pipe extending through the roof.

Air Service

Considerable quantities of compressed air are required at this plant for the operation of pneumatic tools, the blowing out and cleaning of electric motors

For regular service, two main generating sets are installed, each consisting of a 20 by 42-in. single Corliss engine operating at a speed of 120 r.p.m. and direct-connected to a 1202-amp., 240-v., three-phase, 60 cycle alternating-current generator, the fields of which are excited by a 25-kw., 125-v. belted exciter. During light load periods and at night, the electric energy is supplied by a 375-amp., 240-v., three-phase, 60-cycle alternator equipped with a 23.2-amp., 125-v. direct-connected exciter and driven through the employment of reduction gearing by a 190-hp. steam turbine running at a speed of 3600 r.p.m. This equipment is shown in Figs. 1

and 2, while the arrangement of the individual pieces is as indicated in Fig. 5.

Cables carrying the current from the generators to the switchboard are placed in concrete trenches; 13 black slate panels comprise the board. The first of these, which has the upper section hinged so as to allow a full view of all the instruments at any point along the front row of the board, carries two alternating-current ammeters, a frequency meter, one power factor meter, a synchronism indicator and on the fixed section a generator voltage regulator. The second is the exciter panel and is provided with three ammeters, one voltmeter, voltmeter plugs, rheostats and main knife switches, while panels 3, 4 and 5 are for the control of the main generating units and are provided with the usual complements of oil switches, ammeters, kilowatt meters and kilowatt-hour meters.

One alternating current ammeter and an oil switch are on panel 6 for the main control of all current used for lighting; on the adjoining or panel 7 are found nine lighting distribution switches for the control of each of the lighting circuits. Panels 8 and 13 inclusive, each equipped with a single ammeter and an oil switch, are for the control of the individual power circuits.

All lighting units are designed for 110 to 120-v. operation and in order to provide this voltage there have been installed back of the main switchboard three 240 to 120-v. 50-kv.a. transformers delta connected.

All main distribution lines, particularly those serving the new building, are carried in tunnels; all other distribution is overhead.

The maximum total monthly electrical load is approximately 65,000 to 70,000 kw.-hr., the bulk being made up of induction motors and lighting units. Of the former there are 85 ranging in size from 1 to 75 hp. while the main lighting load is composed of six hundred 200-w. gas-filled lamps.

An interesting and a somewhat unique application of electric energy in the piano manufacturing industry is that in connection with three wood shapers used at this plant. Each of these is equipped with a 4-hp. induction motor, the speed of which is 3600 r.p.m., a value, however, considerably less than that required to secure the desired smoothness of cut. Increased speed was possible only by increased frequency and accordingly a 5-kv.a. frequency changer driven by a 2-hp. motor has been installed in connection with this equipment. By its use, the speed of the driving motor may readily be increased to over 7000 r.p.m.

Stability of Cost of Power

IMPORTANCE TO INDUSTRY IN GENERAL OF HAVING POWER COST REMAIN CONSTANT. BY L. W. ALWYN-SCHMIDT

IF THE economic life of any country would be regulated arbitrarily by the rulings of an economic committee, it would have to be one of the first duties of this committee to create a staple economic foundation by making practically unchangeable all the fundamental activities such as power supply, transportation and the annual expenditures of government. A condition would then be created as regards these factors very similar to that existing in the present time as regards gold which, theoretically at least, retains always its value whatever may be the coinage into which it has been cast. A committee with such far reaching powers, of course, is hardly conceivable under our present mode of government, although the formation of our public service bodies is certainly a very near approach to it. Nevertheless there remains the fact of a close connection between cost of production and the cost of power supply transportation, etc. This was fully realized during the war and the various attempts to control the rising tendency of all national overhead expenses have included also a partial control of power production, both at its source in the form of coal control and in its application, as in power conservation and concentration of power generation.

With the increase of this realization of the importance of power as a fundamental factor in our economic life there will increase also the realization of the need of bringing under better control all forms of power generation and power expenditure. Nationalization of power sources, centralization of power production and control of power consumption which are now only feebly attempted in one or the other country may become a general practice all over the world and may in the hands of conscientious men do much to stabilize production and in doing so cheapen the cost of production. In the meantime, the well-being of the nation as regards its power supply and conservation is placed entirely in the hands of the power engineers. This body of men has shown during the war that it is well able to take care of the work, co-operatively and individually. Its aid will now have to be enlisted again in the more difficult problem of how to secure our economic future and growth by producing stabilization in the cost and supply of power during peace time.

Without the existence of power there cannot be any movement, without movement there will not be any progress. The factory wheels are subject as much to the existence of a power source as the trains that bring the men to the factories or the motor trucks that carry the goods to the consumer.

THE EFFECT OF POWER COST UPON PRODUCTION COST IS CUMULATIVE

LET US take the example of a street car moved by the power supplied by a central station. This car, to make its trip from one point of the city to another, requires a certain quantity of power which costs a certain amount of money to produce. The trolley line may pay to the central station for power upon the basis of an equal charge per unit of electrical power. From this payment start two distinct lines of economic action, one leading by way of the central station to the coal mine or the hydroelectric turbines producing the energy, the other to the pocket of the clients of the trolley line and in turn to factory, store or the household.

In each case the further the line gets away from the starting point an increase in value takes place. Beginning at the coal mine, there is the price of the coal,

consisting of labor wages paid to the miner and the other expenses of the mine. The coal is sold and shipped and turned into electrical energy in the central station which in turn sells the power product to the trolley line. Each client of the trolley line buys from the company a certain unit of energy sufficient to move him a certain distance and he charges again his share of the expenditure to production cost in the form of wages or commercial profits as the case may be. The man who goes into a store and buys a pair of shoes pays at the same time not only for the leather manufacturing cost and the dealer's profit, but he pays also a small share of the price of the coal that was mined originally somewhere in Virginia. It may happen that the very miner who mined the coal pays in this way part of his own wages.

Let us now assume that the price of the coal doubles at the mine head. What happens? Theoretically, there would be a doubling of cost all along the line. If the rise in the price of coal is high enough, there will take place, in fact, a general rise of cost leading from the mine head to the shoe store. This condition arose during the war frequently and has been one of the reasons which made necessary an increased control of the nation's resources. In practice, however, and during normal times, price increases are rarely sufficiently large to force an adjustment all along the line. The system of rate regulation applied by our public service commissions prevents such a violent reaction. Economic practice in this country has placed between the coal producer and the power consumer a series of bulwarks and shock absorbers which are found in the flat rates of our railroads, central stations and trolley lines. A rise in the cost of coal of, say, 20 per cent for instance, is not supposed to have any direct influence upon the cost of transporting the coal from the mine to the central stations. The central station has not to pay more for transportation than before. It has to meet only the higher cost of the coal. The cost of transportation remains the same whatever the cost of coal. Public service commissions also will not grant a rate increase to the public utilities for the sale of power unless there is a very heavy increase in the cost of operation. So the trolley line is receiving its power at contract rate and can, theoretically at least, continue to sell transportation to its clients at the old rate.

What happens in the public service is duplicated in a similar way in the private power plant, only the effect of the cost of power production upon the cost of operation is more direct because there is no public service commission to check its action.

Let the power house take the place of the central power station in the former example and there appears the same line of cause and result. Between the coal mine and the power house stands as an economic bulwark the stabilized transportation rates of the railroads. But for the line between the power house and the wheel that turns the machinery of the factory there is no guard of any kind.

Private Power Costs Difficult to Stabilize

In the first example, public interest has helped to create the necessary safety guards against too violent a fluctuation of the cost of power. In the second, all safety guards that can be erected are found in the persons of the engineers in control of the power plant. But the absence of any organized control of this part of power utilization does not mean that it is not required. Neither does it indicate that it is not already exerted by the engineers themselves. It is in the interest of the engineers to operate their power houses as cheaply as possible. While the operation of the power houses, therefore, is carried on economically in most cases there must be necessarily large fluctuations in the cost of the operation in individual plants.

The cost of operating a power house depends upon many factors which differ naturally in different enterprises. The size of the plant and the quantity of power that is produced and consumed has a considerable bearing upon the the cost of the power. The geographical location of the plant affects the cost of fuel and the relative location of the power house to individual units of the manufacturing plant affects the cost of power inside the very factory. Two industrial plants operating side by side and employing the same quantity of power may have an entirely different power expenditure.

A situation is caused very similar to that experienced during the war in our public power supply, when the artificial barriers erected by the public service commissions broke down under the pressure of high prices and power rates began to fluctuate.

This fluctuation of the cost of the essential national services such as that of centralized power supply, transportation, etc., has had a serious effect upon the price situation in the United States. Creating an insecurity in the mind of the producer, a mental attitude has been caused similar to that existing at the present time in the foreign exchange market. If a man knows he can buy the services of one horsepower for such and such a price or one mile transportation for 5 cents, or whatever else the cost may be, he can base upon that knowledge a system of cost accounting as secure as that of computing prices upon the basis of the dollar. If this basis fails him, there goes also one of the main props of his system of estimating.

The variation in the cost of private power, therefore, is a considerable impediment in the way of a general reduction of prices although its effect is possibly not fully realized by our manufacturers.

But while power engineers, no doubt, are doing their best to check the excessive cost of operating their individual power plants, they have no outward means at the present time to bring about a uniform cost of all individual power production. We cannot expect very well to have the fireman's union meet and decide to establish sliding wage scales in the various power houses with a view to make the cost of power production equally expensive or cheap for all manufacturers.

Nevertheless there is a stabilizing element in this situation which assists in bringing about at least a qualified equalization of power cost in private plants. This is the public central station, or the cost of the gas unit of the local gas company.

If the local power rate of the public utility company reaches a certain figure, it would not be wise for any manufacturer operating in the same district to operate his own power plant more expensively than the price for which he can buy power from the central sta-

tion. There may be exceptions to this rule, but the fact remains that the public central station acts as a check upon the growth of power cost in its own neighborhood.

Cost of Central Station Power Regulates Local Level of Cost of Power

This makes it still more desirable that the cost of the power sold by the public utility company should remain unchangeable for long periods. It seems that this fact should be taken into consideration whenever the problem of a sliding scale of rates for public utility service is discussed. This system is based upon the principle that the cost of the principal raw material in power production, which is coal, should have a deciding influence upon the price of the product. The idea underlying the plan is to make the operation of public utilities profitable to the investors and not too costly to the consumer. If the price of coal is high, the public utility company is permitted to add a certain percentage to its cost; if it is low, the rate may fall below its normal standard. The method is certainly a very fair one to producer and consumer alike, but it lacks the element of stabilization which has been so useful to the economic life of the nation in the past.

The relationship of public power cost to private power cost is a very important feature in local power engineering and it should be discussed more fully in engineering circles as should be, in fact, all the economic problems of engineering that have arisen during recent years.

The cost of power production, of course, is of great influence upon the cost of industrial production and any step leading to a possible all round increase in power cost should not be easily undertaken. More important even than low cost is that stable conditions should prevail so as to make it possible for the manufacturer to adjust his prices. The system of sliding scales of power supply rates adds to the power bill each month the adjustment percentage. This means that the manufacturer knows only the price of his power after he has actually used it. He is in the position of a man who orders service from another without having a previous estimate of cost. The variations, of course, can only be small, nevertheless the system is not quite sound commercially, whatever may recommend it in other respects.

The English government used to base its tax system upon the earnings of the taxpayer during the three previous years, drawing an average for the three years. The same principle might be applied to the adjustment rates of our public utility companies, substituting, of course, a shorter period for making the averages. A still better way which has been employed in some instances is to permit a rate movement only after the price of coal has fallen or increased inside a fairly wide adjustment margin. The latter is not quite so fair to the public utility company, but it produces greater stability of power cost.

While the controlling influence of the cost of central station power has a leveling effect upon private power cost it is still very difficult to regulate the basic cost factors of the power plants themselves. Nevertheless an attempt should be made. It stands to reason that, given an equal cost of coal and a uniform system of cost accounting, there should be a possibility of equalizing power cost in plants of similar size. All attempts to stabilize the cost of coal have failed so far, but the chance is that further attempts will be made, one of which most likely will produce a solution of this very difficult problem of national cost accounting. Scientific management then can do the rest.

The whole situation calls decidedly for a greater co-operation of power producers upon a local basis. The power engineers have their national and state associations and are part of the general engineering organization of our country. In view of the great importance of this branch of engineering and its many local problems, local co-operation should be encouraged by the formation of local professional centers.

Results

By C. R. Tighe

RESULTS count! In the power plant as well as in any other industry maximum efficiency must be obtained. This does not mean that absolutely the newest and best equipment must be installed in place of apparatus which has seen several years' service. While this would undoubtedly be a good thing, yet, in many cases, it is uneconomical and impracticable. A great deal depends upon the engineer in charge. If he is the temporizing, alibi-making, newspaper-reading-during-business-hours kind, the results will surely be insignificant, whether the machinery and equipment is new or old, and sooner or later the shirker is found out and relieved of the few burdens which has has assumed. Unquestionably new and modern equipment is easier to keep up to standard, but the engineer must also bear in mind that the standard should be higher in proportion to the worth of the new apparatus over the old. This is not so easy as appears on the surface. Constant vigilance and attention to the equipment is necessary if results are to be achieved and maintained. The careless engineer will soon find that his efficiency is below par, and he will soon be dropped from the payroll to make way for a more energetic and enterprising engineer.

Engineers never had greater opportunities than they have today. At last the world is beginning to realize the value and necessity of the engineer to the community. The layman no longer looks up at the towering skyscraper, the great steel and concrete bridge or the dam holding in leash millions of gallons of water for drinking purposes or for the generation of electricity without giving a thought to the master minds who designed and constructed these marvels of modern engineering.

In view of the splendid rewards which await the younger engineers who make good and the sterling worth of the profession, it behooves the younger men who are just starting out on their careers to give their time and thought to ways and means of increasing their efficiency to the maximum and keeping abreast of the times so that they can successfully cope with the new problems which come up every day.

"A Lazy man is no worse than a dead one, but he takes up more room."

Methods of Recooling Condensing Water---II*

SPRAY PONDS, THEIR THEORY AND DESIGN.
BY THE TERRELL CROFT ENGINEERING CO.

SPRAY FOUNTAINS are often used in connection with cooling ponds. This arrangement (Fig. 2) permits of a considerable reduction in the area of the pond. The fine division of the water particles by the sprays insures a maximum of water surface in small space and thereby facilitates the cooling effect due to evaporation and air contact.

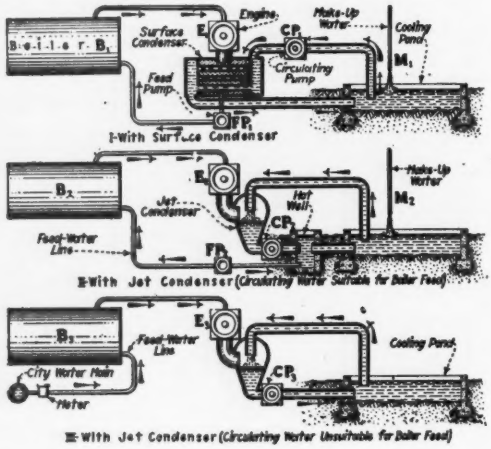


FIG. 1

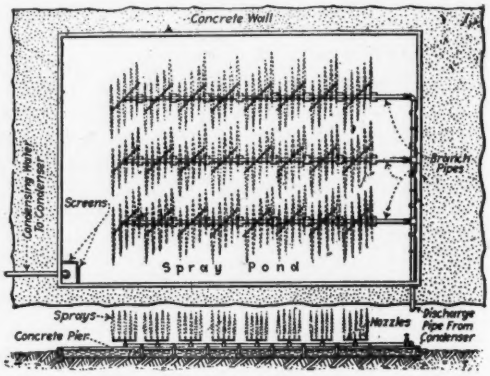


FIG. 2

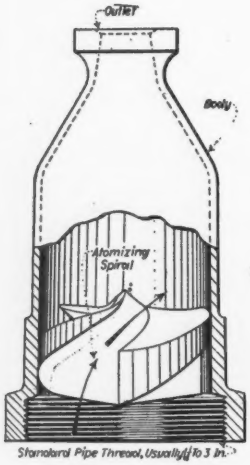


FIG. 3

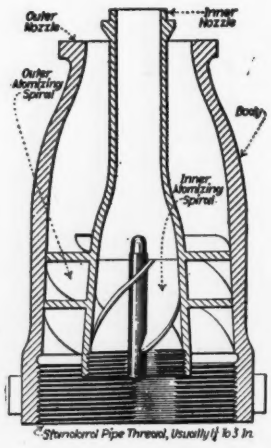


FIG. 4

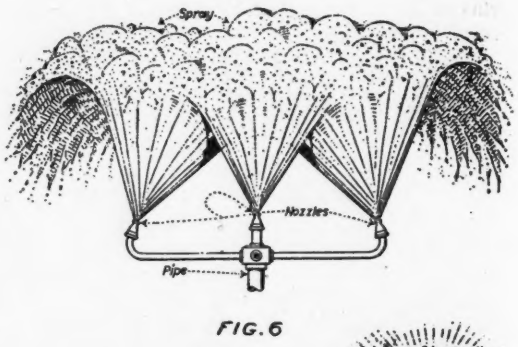


FIG. 6

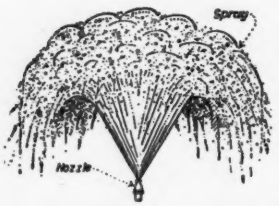


FIG. 5

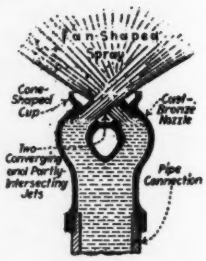


FIG. 7

FIG. 1. THREE POSSIBLE ARRANGEMENTS OF CONDENSING EQUIPMENT. FIG. 2. COOLING POND WITH SPRAY FOUNTAIN. FIGS. 3 AND 4. TYPES OF SPRAY NOZZLES. FIG. 5. FORM OF SPRAY FROM SINGLE SPRAY NOZZLE. FIG. 6. FORM OF INTERMINGLED SPRAY FROM THREE NOZZLES. FIG. 7. IMPACT SPRAY

The passage of the water through the cores of the nozzles, Figs. 3 and 4, on a spray fountain, breaks it into a fine mist. These nozzles are, generally, set either vertically or at an angle of 60 deg. with the horizontal, as at J, in Fig. 8. These arrangements secure a wide distribution of the spray and also tend to induce air currents, even on calm days, which greatly augments the cooling effect.

The conditions which mainly control the amount of recooling produced by spray fountains have been determined by tests. It has been demonstrated (Fig. 9): (1) That recooling is more affected by the air temperature and humidity than by the temperature of the water coming from the condensers. (2) That with 80 to 90 per cent relative humidity, the water temperature can be lowered to within 12 or 13 deg. F. of the dry bulb air temperature. (3) That with 20 to 30 per cent relative humidity, the water temperature can be lowered about 8 deg. F. below the dry-bulb air temperature. (4) That the loss of water is usually about 6 per cent.

* This material constitutes a portion of the author's forthcoming book, "Steam Power Plant Auxiliaries and Accessories." It is copyrighted by the author and all rights are reserved.

To compute the temperature reduction which can be effected by a spray-nozzle installation the following formula can be used:

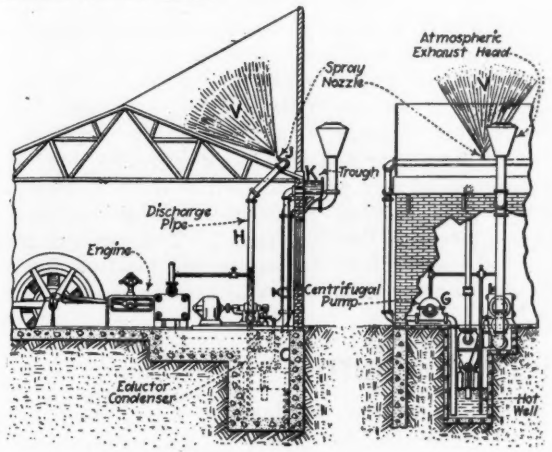


FIG. 8. UTILIZING ROOF SPACE FOR SPRAY COOLING

$$T_2 = T_1 - \frac{(T_1+T_x+920)^4 - 16(T_x+460)}{16(K\times 10^8)}$$

Wherein, all temperatures are in degrees F. and: T_2 = temperature of cooled water after spraying. T_1 = temperature of water before spraying. $T_x = (4T_w + T_d) \div 5$. T_d = dry-bulb-thermometer or air temperature. T_w = wet-bulb-thermometer temperature. K = a constant = 5.1 for average installations operating at 6½ lb. water pressure, but it may vary from 4.4 to 5.7; it varies with the wind velocity and the pressure with which the water is forced through the spray nozzles.

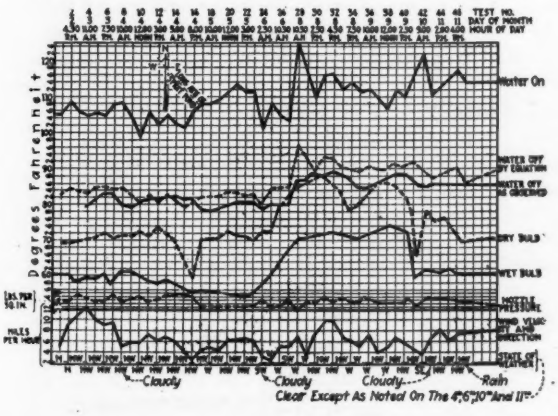


FIG. 9. GRAPH OF SPRAY NOZZLE TEST (CIRCULATION = 5000 GAL. PER MIN.)

By using values from Table I, page 361, Apr. 1 issue, the probable temperature reduction which may be expected in any locality can be computed.

The size and number of nozzles to be used in a spray fountain (Table I), depends upon the quantity of water to be handled. It is commonly assumed that a single spraying system will, under normal conditions, cool the water about 20 to 30 deg. F. This is considered sufficient for ordinary steam-condenser service; however, it is often considered desirable to spray from 25 to 55 per cent of the condensing water a second time before sending it through the condenser.

Spacing of Nozzles

THE SPACING of the nozzles in a spray fountain depends mainly upon the design and size of the nozzles.

TABLE I. TABLE SHOWING SPRAY NOZZLE CAPACITIES IN GALLONS PER MINUTE

Pipe-Size of Nozzle, In Inches	Pressures On Nozzles, In Pounds Per Square Inch.					
	5	6	7	8	9	10
2	54	60	65.5	70.5	75	78
2 1/2	77	85	92	98	103	106
3	115	125	135	140	146	151

Note.--Nozzles of 2-in. pipe-size are most frequently used. These are commonly regarded as the most economical. The outlet orifice in the tip of a 2-in. nozzle has a diameter of about 0.8 in. The hydraulic pressure required to force the water through the nozzles should never exceed about 14 lb. per sq. in., gage.

Centrifugal nozzles of 2-in. size are usually spaced about 8 to 10 ft. from center to center. Nozzles of larger size may be set proportionately further apart.

A typical installation, spraying 4800 gal. per min., consists of nine rows of nozzles, with eight nozzles in each row. Thus, each nozzle sprays $4800 \div (9 \times 8) = 66\frac{2}{3}$ gal. per min. The rows are 20 ft. apart, and the nozzles are spaced 13 ft. between centers. A 2-in. nozzle (Table I) at a little over 7 lb. per sq. in. water pressure would meet these requirements.

The ground area required for spray-fountain ponds is much less than that required for simple cooling ponds. It is commonly assumed that for small plants, under 500 hp., 1 sq. ft. of surface will suffice for the cooling of 150 lb. of water per hr. For plants of about 5000 hp., 1 sq. ft. of surface will usually suffice for the cooling of 250 lb. of water per hr. For plants of about 1000 hp., 1 sq. ft. of surface may be assumed as sufficient for the cooling of 200 lb. of water per hr.

TABLE II. TABLE SHOWING RELATED DATA OF SPRAY FOUNTAIN INSTALLATIONS

Condenser-Vacuum In Inches	Pounds Of Condensing Water Per Pound Of Steam	Gallons Of Condensing Water Per Pound Of Steam	Rise In Condenser Of Condensing Water Temperature In Deg. Fahr.	Temperature Of Water Leaving Condenser In Deg. Fahr.	Cooling Required In Deg. Fahr.	Cooling Obtained In Deg. Fahr.	Temperature Of Water After Spraying In Deg. Fahr.	Excess Of Water Temperature Above Air-Temperature Of 70 Deg. Fahr. In Deg. Fahr.
28	50	6	30	92	30	30	72	2
27	35	4.2	29	105	29	29	76	6
26	30	3.6	34	110	34	39	81	11

Spray fountains should be surrounded by windbreaks in order to avoid excessive water loss, due to heavy winds.

Sometimes they are located on power-house roofs, as shown in Fig. 8. This is usually done where ground area is unavailable. The extra power required for elevating the condensing water may, with some types of condenser installations be offset by utilizing the hydrostatic head, thus obtained, for sending the recooled water through the condenser.

For instance, the water from the hot well, Fig. 8, is pumped to the spray nozzles, J, by the centrifugal pump, G. through the discharge pipe, H. The recooled water in the spray, V, runs into the trough, K. It then flows through the eductor condenser, C, under the head due to its elevation above the hot well.

Power Required

The power required to operate a spray fountain in connection with a steam-condenser equipment is not great. The pressures generally used seldom require more than 1.5 to 2 per cent of the main-engine power. This is equivalent to about 10 per cent of the power saved by condensing over non-condensing operation. The circulating pump may often be used to deliver the water directly to the nozzles. Installation of additional pumping equipment is thereby avoided. This can generally be done with surface condensers and low-level jet, or eductor condensers, but not with barometric condensers.

Regulation of Fuel Oil Burner

Automatic Control of Oil, Steam and Dampers in Harmony with Steam Pressure. By Charles W. Geiger

THE accompanying illustrations show a new system of damper control and oil-burner regulation, that has recently been perfected. The system automatically controls the oil and steam to the burners, and the ash pan and stack dampers.

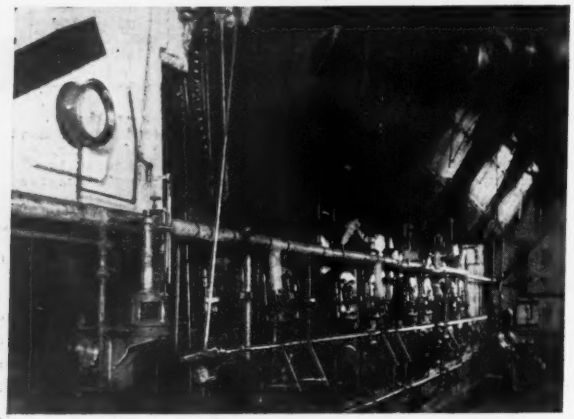


FIG. 1. BATTERY OF BOILERS EQUIPPED WITH AUTOMATIC REGULATOR FOR OIL BURNERS

Figure 1 illustrates the installation at the California Glue Works. Figure 2 is a drawing showing the device that controls the oil and steam to the burners. This regulator handles the steam and oil in the proper proportion, and maintains a steady pressure of steam on the boiler. The method of adjusting the regulator is as follows: Valves 1 and 2 are opened and valve 3 is shut. Valves 4 and 5 are opened and valve 6 is closed. This operation puts the apparatus in connection with the burners. The operator then opens the steam valve on the burners wide and screws down on the adjustment screw on the regulator until steam starts to come through the burners. Then he opens the oil valve at the burner enough to produce a clear flame. The boiler pressure gage must then be watched and if the pressure is inclined to go down, the tension of the spring is increased. This adjustment, once made, remains permanent. In shutting down at night, the steam and oil is shut off at the burner. In starting up, steam and oil at the burner is operated by hand until the steam in the boiler has reached the set pressure, then the steam valve is opened wide and the oil valve opened sufficient to atomize, and then the regulator will take care of it.

The absence of any irregular firing, causing excessive expansion to the boiler and brickwork is eliminated and the greatest economy in the upkeep of the equipment is effected. A very desirable feature of this system is the fact that the regulator can be taken out and repaired if necessary without shutting down the plant.

The regulator is placed close to the boiler fronts and centrally located between the boilers.

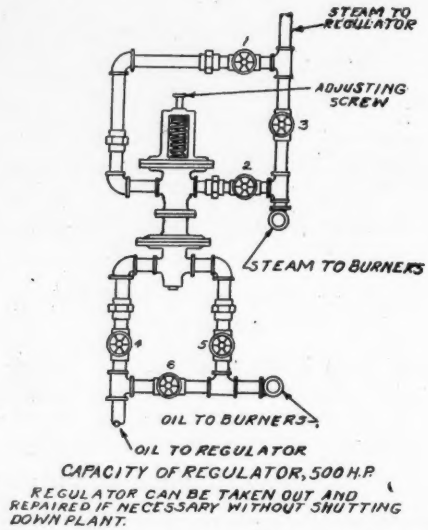


FIG. 2. BYPASS OF OIL AND STEAM REGULATION

At another plant two regulators are installed, one being for operating the boilers at 80 lb. steam pressure during the day, and the other for operating the heating system at night when only about 1½ lb. of steam is required. One regulator could take care of both of these pressures, but having two eliminates the necessity of making the adjustments for the two steam pressures.

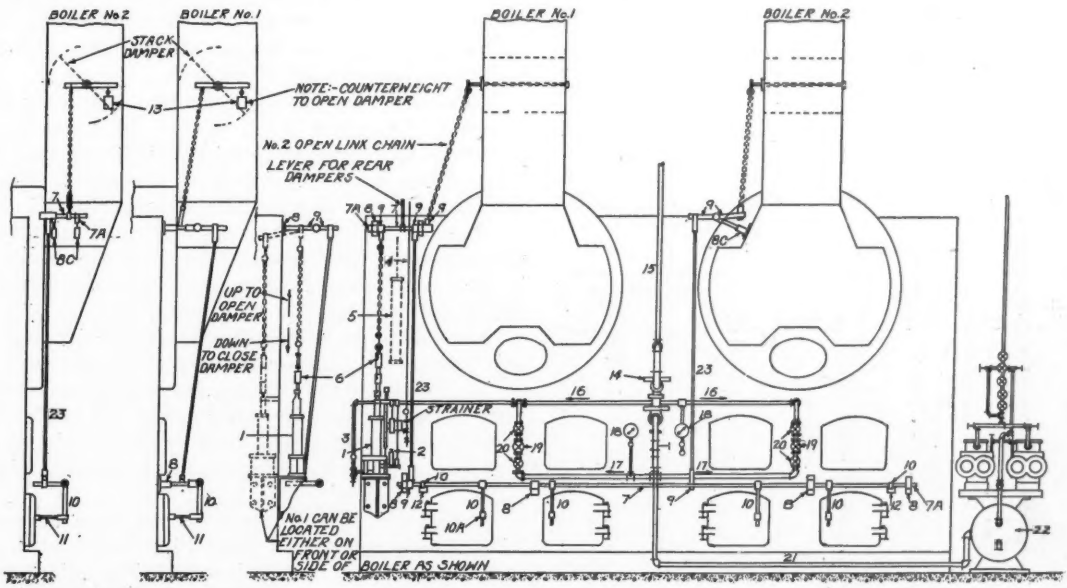
Steam for operating the regulator is taken from a line that is of ample capacity. If this is not possible,

a new and independent line is run from the boilers to the regulator. This is very important, as the apparatus must have the true boiler pressure and not a false pressure, which is the condition in the steam lines where the draw on it is excessive. A riser about 6 in. long is placed on the line from which the steam is taken. This prevents any condensation from coming into the burner line and insures dry steam at all times. All connections are made as direct as possible, all unnecessary bends and fittings being eliminated.

The damper control works in conjunction with the regulator, increasing or decreasing the air supply, thus insuring perfect combustion with a minimum amount of air. This device is positive in action and has sufficient power to operate any number of dampers.

automatically to keep a steady steam pressure on the boilers, by regulating the amount of oil and steam to the oil burners, and also the proper amount of air through the ash-pan dampers to the furnace for combustion, and at the same time closely regulating the stack damper to reduce the velocity of the gases and retain the heat over the heating surface in the furnace, and thus reduce the amount of excess air and consequent heat losses at the stack.

The need of a burner regulator is a necessity for high efficiency in the average plant, and this automatic regulator and damper control will show a saving in oil, steam and air losses, and boiler troubles, etc., in general, by its close and positive control if properly adjusted and properly installed.



1 - Draft Regulating Damper Control.
2 - Adjusting Screw for length of stroke.
3 - Reduced Steam Pressure from Burner Regulator.
4 - Water Pressure Connection to Pilot Valve.
5 - Receiver (Provide receiver if condensed steam used)
6 - Adjustable Turnbuckle with No. 2 open link chain.
7 - Rock Shaft (1¼" Std. Wt. Pipe) with Stop Collars, 7A.
8 & 8C - Adjustable Bearings.
9 - Adjustable Lever, Clevice and Socket for Connecting Rod.
10- Adjustable Lever and Socket 10A.
11- Flexible Cable, Clevice and Eye Bolt for Door.
12- Counter Weight for Lever 10.
13- Counter Weight for Stack Damper.
14- Automatic Regulator of Oil and Steam to Burners and Boiler Pressure Regulator with By-passes.
15- Steam from Boiler to Regulator.
16- Reduced Steam from Regulator to Burners.
17- Reduced Oil from Regulator to Burners.
18- Pressure Gauges (Steam and Oil)
19- S.& P. Automatic Steam Atomizing Oil Burner.
20- Steam and Oil Valves.
21- Oil Pump Discharge.
22- S.& P. Aut. Fuel Oil Pumping and Heating Systems.
23- Connecting Rod - 3/8" Std. Wt. Pipe.

FIG. 3. DIAGRAM OF REGULATING SYSTEM FOR OIL BURNERS

Reduced steam pressure from the burner regulator is used to operate the draft regulating damper control. It is provided with a screw for adjusting the length of the stroke. The piston of this control is connected to the chain shown at 6 in Fig. 3, which extends up to the rock shaft. This rock shaft is connected to the stack damper of boiler No. 1 by means of an open link chain. The connecting rod 23 connects this rock shaft with the rock shaft 7, which is provided with a counterweight 12; 10, 10 shows the adjustable levers that connect the rock shaft with the doors.

This oil and steam to burner regulator, with ash-pan damper regulator and stack-damper controller for the accurate regulation of steam, oil and air, by the positive action from the boiler steam pressure, is designed for any average size boiler plant and conditions where a cheap, simple, accurate and reliable device is needed

ACCORDING to an authoritative review, France, in 1919, had increased her developed "white coal" resources by over 400,000 hp. compared to her pre-war use of water power. The detailed statistics received by the Bankers Trust Company, of New York, from its French Information Service, show that out of about 9,000,000 hp. available France has hydraulic works capable of utilizing 1,165,000 hp. Before the war, about 750,000 hp. was developed. The review indicates that from 1915 until early in 1918 government and private enterprise utilized water works representing only 565,000 hp. It is estimated that in 2 yr. more than 500,000,000 francs have been spent in France on water power installations.

AFTER ALL, you've got to give full, fair value or you won't last.—Forbes Magazine.

Elevator Inspecting

POINTS AND PRECAUTIONS TO BE OBSERVED BY ENGINEER WHEN INSPECTING ELEVATORS FOR SAFETY. BY ARTHUR D. PALMER

THE PROPER place to begin the inspection is in the machine room. Often, this room is located on the roof, and is practically inaccessible; but this is no excuse for the machine not being inspected. Keep in mind that a machine out of order might cost you your life.

In looking over the machine, the work can be divided into parts. Assuming that we have an electrical machine, we could divide the inspection into the following order: Motor, shaft, flange, brake, case, gears, drum, pedestal, bearings, limit stop, vibrator, slack cable device, control board. Each of these parts should be carefully inspected for the following defects.

When examining the motor consider the commutator, is it clean, and does it run true? Do the brushes fit properly? Is there any sparking? What is the general condition as regards cleanliness of the rotor, poles, windings, etc.? Keep in mind the fact that motors used in elevator work are generally of special design, as the work these motors have to do is very exacting. It is essential that a motor used in elevator work be of a type that will start under full load, that it will be able to hold that load, and pick up its speed in 4 to 10 sec. without any drop in speed. In general, d.c. motors are met within this field, the advantage in this type of motor being in the low speed, high starting torque, heavy frames, and well designed field cores. Look for proper area of commutator contact, see that brushes are held in proper position, and that holders do not allow clatter when the motor is running. In general, the motor should have liberal windings, good field cores and an extra heavy frame and base.

STRENGTH AND WEIGHT OF IRON HOIST CABLES

Diam. inches	Cir. inches	Weight per ft. lbs.	Strength in ton 2000 ton	Safe load in ton 2000 ton	Diam. of drum Feet.
2 3/4	8 5/8	11.95	111	22.2	17
2 1/2	7 7/8	9.85	92	18.4	15
2 1/4	7 1/8	8.	72	14.4	14
2	6 1/4	6.30	55	11.	12
1 7/8	5 3/4	5.55	50	10.	11
1 3/4	5 1/2	4.85	44	8.8	11
1 5/8	5	4.15	38	7.6	10
1 1/2	4 3/4	3.55	33	6.6	9
1 3/8	4 1/4	3.	28	5.6	8.5
1 1/4	4	2.45	22	4.5	7.5
1 1/8	3 1/2	2	18.6	3.7	7
1	3	1.58	14.5	2.9	6
7/8	2 3/4	1.20	11.8	2.3	5.5
3/4	2 1/4	.89	8.5	1.7	4.5
5/8	2	.62	6.	1.2	4.
9/16	1 3/4	.50	4.7	.94	3.5
1/2	1 1/2	.39	3.9	.78	3
7/16	1 1/4	.30	2.9	.58	2.75
3/8	1 1/8	.22	2.4	.48	2.25
5/16	1	.15	1.5	.30	2
1/4	3/4	.10	1.1	.22	1.50

Occasionally a.c. motors are met with in this field, and care should be taken to ascertain if they are of a proper size for the work. Due to their lack of ability to start under full load, it is generally considered good practice to have such motors about 35 per cent larger than the d.c. type.

The shaft should be measured for diameter. Shafts used in ordinary motor drives are not large enough for elevator drives. Note that an elevator motor shaft has to pick up a full load in starting.

Having gone carefully over the motor we next come to the brake. In a great many machines we will find that the brake wheel is also the flange that connects the motor and drive together. In all modern machines, the brake consists of two jaws, wood or leather lined, connected together by a spring at one end and a solenoid at the other end. Careful inspection will disclose if brake is slipping; note when machine stops whether drum still turns. Loose leathers on face of bands should be looked for; leathers worn down to rivets should be renewed, and oily or dirty leathers should be cleaned. Hammer test the bolts in flange, and try keys, etc.

Carefully look over the case of gearbox, note if case is oil-tight, and fits joints properly.

In general, there is a plate which can easily be removed in the casing, and a view of the gears can thus be obtained. Note the wear and note whether gears are running in line, indicated by the wear. Note the oil, whether clean and distributed properly.

Hammer test the bolts, nuts and spokes of structure that makes up the drum, look for loose keys and cracks in the drum itself. Note the condition of grooves, and whether wear is even in all grooves.

See whether pedestal is firm on foundation, look over and hammer test anchor bolts; note vibration.

In inspecting the bearing, remove the oil caps and test with finger tip. Note whether chains in chain type bearings are working, and rings in ring bearings. Bearings located in dusty cellars should be protected by end caps.

Machine limit stops generally act upon the control. They usually consist of a screw with a worm gear, which acts upon a lock nut at each end of shaft, which in turn acts upon the control. Note if the limit stop travel is equal, have the machine run to top and bottom of hoistway and note the travel of the nut on worm.

Note as the car travels whether the vibrator pulley follows cable, and guides it in grooves of the drum. Note oiling of vibrator shaft.

The slack cable device is generally located under the drum and a few inches from the hoisting cables. In general, these devices consist of a rod upon which the cable drops, the outer attachment on this rod acting on the brake and control. In general, this device should be tested by operating it.

In looking over the control board, look for short circuits, dirty contacts, loose bolts, spring not properly adjusted for tension, and improper fuse connections. This may be, say, to finish the inspection of the machine. If the machine is located in a cellar where it is accessible to the public, it should be guarded, either by a proper housing or by netting, with a locked door.

While in the basement inspecting the pit, look for dirty water, waste paper, and any condition that to your mind is unhealthful and detrimental to the machine. If a freight elevator, note whether warning chains are on the car bottom. Chains should be 30 in. long, set on 6-in. centers. Note condition of bump-

ers; see whether counterweight is protected to standard. This means a 7-ft. runway for the counter weight.

We now come to the inspection of the car itself. The first consideration is in the matter of classifying the car. Insurance companies have different rates for different cars, hence the matter of correct classification is important. The following list gives the direct classification of all commercial elevators.

Classification

Passenger, Used for passengers.

Freight, Used for freight.

Freight and Passenger, Used for both.

Sidewalk, Operates outside of building. Does not rise above sidewalk.

Jumper, A counterweighted platform, no power, two floors only.

Man Hoist, Same as above, serves more than two floors.

Wool Whip, Hoisting device, used for hoisting bales, etc.

Hand Hoist, Hand operated hoist, no platform, through hatchway.

Lowerator, A gravity lowering device, operated through hatchways.

Dumb Waiter, Any elevating device so constructed that it is impossible to carry passengers.

Automatic, Equipped with automatic push-button control.

Automobile, Used for auto moving.

Esculator, Moving stairway.

One Story Elv., Not more than two landings, and not having a total rise over 35 ft.

Having decided upon the correct classification, the matter of floor area should be taken up. If car capacity is not known the area in feet of the floor multiplied by 50 for freights and 75 for passenger cars will give the capacity. Where the speed is not known, it can generally be assumed. Note the enclosure of the car. Measure for height. Give material of which it is constructed. Note the entrances to the car, and give date on how these entrances are protected. Tell the height of the gates, how built, one or more bars, etc., and look over the method of locking. One thing that the inspector will find is that a great many gates are tied up and are therefore useless. The proper precedent in a case of this kind is to cut the rope holding the gate up. Do not confuse the shaftway doors with car doors. Gates and doors which do not move with the car are not car doors.

In looking over the shaftway, note the construction. All shaftways should be fireproof, with fireproof doors. Doors should lock on the inside; each floor should be provided with a signal button, and the top of the shaftway should be provided with a light. Note any shear-points as car moves up. At the top landing, note the distance the car clears the overhead supports. In good practice, a clearance of 3 ft. is allowed. Look over the limit stop which is usually located on the guide rail and with contacts broken try to start the car. In service, the car opens or closes a switch on this limit stop, which closes a circuit to the brake solenoid, thereby setting the brake. In general, limit switches are applied to both the top and bottom of hoistway.

Cables

In inspecting the cables, great personal care must be taken. An auto mirror with a handle is a useful tool for this work. First have the operator run the car up and down very slowly and examine the cable from the drum. Breaks come on the under side of the cable and in general a break of five wires in a strand does not warrant renewal of the cable unless there are a number of such breaks. Note the wear of cable, and look over the grooving of the drums. Sometimes it will be noted that bad wear shows up in a particular spot on the cable; this is generally due to difference in the wearing of the drum grooves; in other words, if one groove has a lesser diameter than the others, there will be slippage, which tends to wear out the cables. Still another detail in ordering a new cable is to be sure that the cable is right size of grooves. Often a groove by an old cable will be worn so that it pinches the new cable, shortening the life of the rope. Broken wires can easily be detected with a mirror throughout the length of the cable, but broken wires in the connection on top of the car are somewhat difficult to detect. This break is caused by the flexion produced by the cable swinging from side to side. In other words, there is a tendency for the cable to unwind and rewind itself as the car goes up and down. A good remedy for this is the ball bearing shackle. Look over the eye of solid cone closed sockets, for cracks and wear. In open sockets, note whether the bolt is worn, whether cotter pin is in place, and the general condition of the cone into which the cable is soldered. In a swivel hook and thimble connection be sure the hook is sound. Where clips and clamps are used, make sure that all bolts are in good condition and that all nuts are set up tight. All cables should have at least two turns around the drum when car is at extreme of travel. Be sure that no cable runs over another cable on the drum. The accompanying table gives the standard size, and other data relative to iron hoisting cables, made in 6 strands—19 wires to the strand—one hemp core.

By multiplying the strength and safe load by 2, the readings can be changed for steel cables; other dimensions are the same.

While on the top floor, examine the sheaves, look over the shaft in bearings, note condition of lubrication; in places where sheaves are hard to get at, it will often be found that lubrication is badly neglected. Look over the governor if the machine has one, try the spring tension, and throw the clutch to ascertain whether it will properly clutch the cable. Be sure that supporting beams have some form of protection under them, as loose bolts, tools, etc., might well drop and injure passengers in car, even with car covered.

Nearly all car safeties consist of wedge, cams and spring construction; they are designed on the principle that if the car starts to fall, either the wedge or cam will bind on the track, stopping the car from dropping. A way to test these devices is to run the car to the basement, block up and have the operator lower the car to blocking, then knock blocking out and note whether the safeties hold the car from dropping.

In winding up the inspection, ride down on top of the car, note conditions of guide rails, and have the car stopped for inspection of counter weights. Note

how they are constructed; if through bolts, note whether properly set up, and nuts are tight. Look over cable connection, and the lubrication of runway.

The foregoing briefly gives some idea of the proper method of doing this work. Books could be written giving the details and explaining methods of overcoming elevator defects. This article merely gives the method which should be employed by the insurance inspector.

The following formulas will have value to the inspector in the field.

Formula for finding allowed load on given cable.

TS. $\times$ A $\div$ F. S = Load

TS.—Tensile Strength = 70,000 lb.

A—Area of the cable.

FS—Factor of safety = 10.

Motor size for a certain lift at a given speed.

W $\times$ S $\times$ 2 $\div$ 33,000 = hp.

W—Load to be lifted.

S—Car speed in feet per minute.

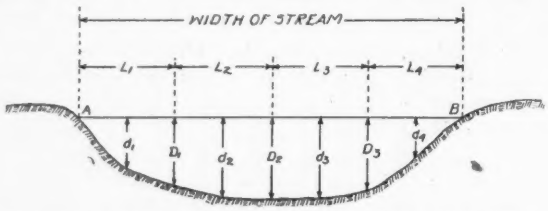
2—Twice the horsepower due to friction.

To find car capacity, allow 75 lb. per foot of floor area for passenger type cars and small freights. For large freights and automobile cars, allow 50 lb.

Small Water Power Developments

A Discussion of Factors Requiring Attention in Conducting the Preliminary Surveys

IN MAKING the preliminary survey for the development of a water power, a number of factors require careful consideration if the project is to prove successful from both an engineering and a financial point of view. The volume of flow and the head determine the number of horsepower available and although at the time of investigation the former appears to be of a value to insure an ample amount of power to meet any demand which may be placed upon the proposed plant, it is well wherever and whenever possible to determine, either through records or an extended survey, the maximum variation in flow. Should the development be subject to deficiencies extending over short periods of time, these may generally be cared for



Determine width of stream; then at uniform distances as L_1, L_2 etc. measure depths D_1, D_2 etc. and midway between depths d_1, d_2 etc.

d_1 then represents average depth between A and point at which D_1 is taken; d_2 represents average of D_1 and D_2 and so on.

Multiplying and section length as L_1 by average depth as d, will give area of section under consideration.

Repeating this for each section as L_1, L_2 etc. and taking sum will give total sectional area.

FIG. 1. METHOD OF CALCULATING CROSS-SECTIONAL AREA OF STREAM

by the employment of ponds. When, however, seasonal deficiencies of considerable consequence occur and no ample storage facilities are available, recourse must be had either to the use of standby steam plants or to electrical interconnection with a system or systems fed by other hydroelectric or steam stations. Only in this way may a continuous supply of energy be assured.

Determining Stream Flow and Head

STREAM FLOW is ordinarily expressed in cubic feet per minute. This may be determined approximately and suitably for all practical purposes in the case of comparatively large streams by selecting a point at which the bed is fairly even and the opposite banks nearly parallel. Here at uniform distances measure the depth of the water along a line perpendicular to the center of the stream and with this data and the width of the stream parallel to this line determine in the manner indicated in Fig. 1 the cross-sectional area of the water in square feet.

FIG. 2. ILLUSTRATING METHOD OF DETERMINING STREAM FLOW BY MEANS OF WEIR

The rate of water flow is then determined by placing at the center of the stream a float that sinks well into the water and observing the time required for it to travel from one fixed point to another. With the rate of flow thus known and expressed in feet per minute, the number of cubic feet of water flowing in the stream per minute may be obtained by multiplying this factor by the cross-sectional area of the stream in square feet. Approximately 85 per cent of this will be the amount available for power production purposes.

In the case of small streams, however, measurement may be made by means of a weir, which, as shown in Fig. 2, consists essentially of a board having cut in it a beveled edge notch with the sharp edge toward the upstream side and of a width equal to about six times the greatest depth of water flowing over it. The bottom edge of the weir should be not less than 1 ft. above the surface of the water below the downstream side. A stake is then driven a few feet upstream to a depth such as will bring the top of it level with the bottom edge of the weir and with all the water flowing over the weir, depth C over top of the stake is measured. With this value known, the number of cubic feet of

water flowing each minute for each inch of weir width may be obtained by reference to the table.

Let us assume that the width of a typical weir is 50 in., the depth, C, 10 in. and that it is desired to determine the number of cubic feet of flow over the weir per minute. Referring to the table, we find that with a 10-in. value of C, 12.71 cu. ft. of water are flowing over each inch of weir width per minute or for the 50-in. width, 50 times 12.71, or 635.50 cu. ft. per min.

Measurement of steam flow may also be made by means of meters especially designed for the purpose. These are, however, generally used only in the case of large developments.

Determining Horsepower Available

Knowing the average head, H, in feet, the quantity of water flowing per minute, Q, expressed in cubic feet, and the weight of a cubic foot of water, W (62.36 lb. at 60 deg. F.), the approximate number of horsepower

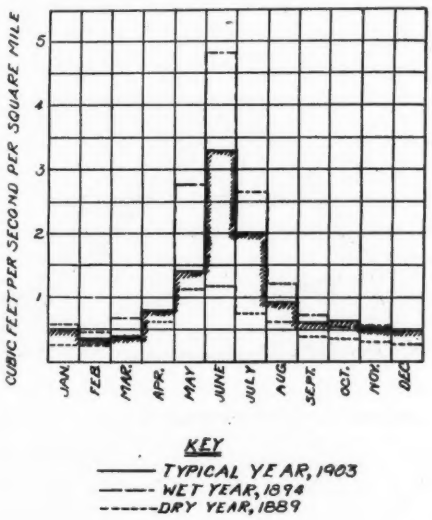


FIG. 3. TYPICAL HYDROGRAPH

capable of being developed (this disregarding the efficiency of the wheel or turbine used) may be readily determined by dividing the product of H, Q and W by 33,000 or

Horsepower = (H × Q × W) ÷ 33,000 which, with W equal to 62.36 becomes

$$\text{Horsepower} = 0.001{,}89\ Q\ H.$$

This is the gross value and should be multiplied by the efficiency of the wheel or turbine expressed as a decimal. With an efficiency of 0.80, or 80 per cent, the net horsepower would be equal to

$$0.80 \times 0.001{,}89\ Q\ H.$$

The actual power may also be calculated on a second-feet flow and 80 per cent turbine efficiency basis by the formula

$$\text{Horsepower} = (Q' \times H) \div 11.$$

in which Q′ is the rate of flow in cubic feet per second and H is the effective head in feet.

As a rule all practical computations for horsepower are made on the basis of the effective head existing at the nozzle.

Pondage and Storage

As ordinarily employed the term "pondage" refers to the facilities provided to care for deficiencies of but a few hours or few days at most while storage indicates capacity sufficient to supply water needed throughout any prolonged dry or partially dry period. Naturally, therefore, the question of storage is of greater importance than that of pondage and either may be obtained

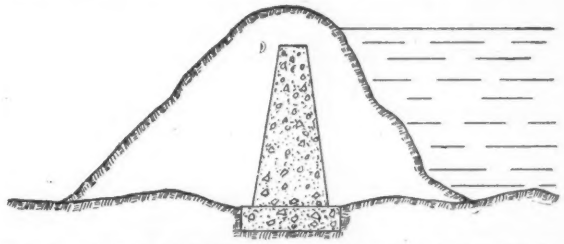


FIG. 4. SECTION OF EARTHEN DAM HAVING A CONCRETE CORE

through the use of adjacent lakes or swamps, the damming of the stream or tributary streams at favorable points or the raising of existing lakes. Obviously the first mentioned scheme, if feasible, is the most desirable.

Whether or not storage or pondage, or both, are necessary will require not only a knowledge of the maximum water requirements for power producing purposes but also a knowledge of the seasonal variation of

MINUTE CUBIC FEET OF WATER 1 IN. WIDE FLOWING OVER WEIR

Inches Depth Over Stake C		1/8 In.	1/4 In.	3/8 In.	1/2 In.	5/8 In.	3/4 In.	7/8 In.
1 Inch	.40	.47	.55	.65	.74	.83	.93	1.03
2 "	1.14	1.24	1.36	1.47	1.59	1.71	1.83	1.96
3 "	2.09	2.23	2.36	2.50	2.63	2.78	2.92	3.07
4 "	3.22	3.37	3.52	3.68	3.83	3.99	4.16	4.32
5 "	4.50	4.67	4.84	5.01	5.18	5.36	5.54	5.72
6 "	5.90	6.09	6.28	6.47	6.65	6.85	7.05	7.25
7 "	7.44	7.64	7.84	8.05	8.25	8.45	8.66	8.86
8 "	9.10	9.31	9.52	9.74	9.96	10.18	10.40	10.62
9 "	10.86	11.08	11.31	11.54	11.77	12.00	12.23	12.47
10 "	12.71	12.95	13.19	13.43	13.67	13.93	14.16	14.42
11 "	14.67	14.92	15.18	15.43	15.67	15.96	16.20	16.46
12 "	16.73	16.99	17.26	17.52	17.78	18.05	18.32	18.58
13 "	18.87	19.14	19.42	19.69	19.97	20.24	20.52	20.80
14 "	21.09	21.37	21.65	21.94	22.22	22.51	22.79	23.08
15 "	23.38	23.67	23.97	24.26	24.56	24.86	25.16	25.46
16 "	25.76	26.06	26.36	26.66	26.97	27.27	27.58	27.89
17 "	28.20	28.51	28.82	29.14	29.45	29.76	30.08	30.39
18 "	30.70	31.02	31.34	31.66	31.98	32.31	32.63	32.96
19 "	33.29	33.61	33.94	34.27	34.60	34.94	35.27	35.60
20 "	35.94	36.27	36.60	36.94	37.28	37.62	37.96	38.31
21 "	38.65	39.00	39.34	39.69	40.04	40.39	40.73	41.08
22 "	41.43	41.78	42.13	42.49	42.84	43.20	43.56	43.92
23 "	44.28	44.64	45.00	45.36	45.71	46.08	46.43	46.81
24 "	47.18	47.55	47.91	48.28	48.65	49.02	49.39	49.76

The James Leffel & Co.

flow preferably throughout a period of years. This information is, as a rule, readily obtainable from the records of the U. S. Geological Survey; but if not, and if time permits, such records should be obtained by actual observation and plotted in the form of a hydrograph as shown in Fig. 3. Preferably such a hydrograph, if to be considered complete, should employ

records not only for normal years but also extremely dry and extremely wet years, thereby providing an actual and complete history of the stream in question.

Another matter requiring careful consideration is the development of the storage facility for if undeveloped, water which might otherwise be held in reserve for future use, will be wasted. A reservoir approaching the ideal is one which will fill once during a normal year without appreciable waste and is of sufficient capacity to provide an ample flow of water to the turbines throughout at least two successful dry years.

Preferably the storage reservoir is placed near the head water of the stream, for with such a location all developments are benefited. The methods of drawing

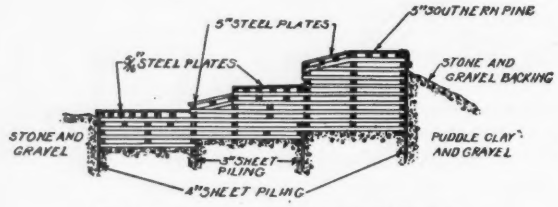


FIG. 5. A TIMBER DAM OF CRIB FORM

upon these reservoirs vary according to local conditions. Frequently it proves advantageous to let the water down at a uniform rate throughout the year, while in other cases it has been found more desirable not to open the gates except during dry periods.

Dams

Dams in general use are earthen, timber, masonry or concrete. Earthen dams are suitable only for the purpose of stream deflection and can not be used where water is to flow over the crest. Frequently masonry or concrete cores are used in connection with earthen dams in the manner indicated in Fig. 4.

A mixture well suited for earthen dams and as recommended by Fanning consists of 100 parts coarse gravel, 33 parts fine gravel, 15 parts sand and 20 parts of clay.

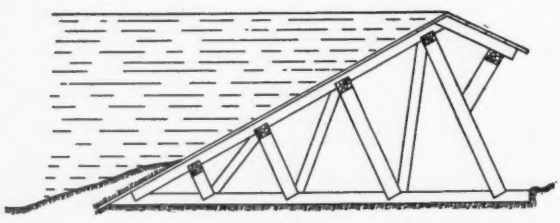


FIG. 6. A TIMBER FRAME DAM

Timber dams, which possess the advantage of being comparatively cheap, and readily built, may be used in almost any small or medium sized development. A serious disadvantage to their use is the rapid deterioration of the members above the water line; those below the water line will of course last indefinitely.

In general, timber dams may be constructed as shown in Fig. 5 by piling up logs in square "cribs," filling these with loose stones and covering the upper surface with 2-in. planking, or, as indicated in Fig. 6, by a framework of heavy timber also filled with heavy stones and gravel and topped with planking.

Masonry dams may be built up either entirely of cut stone laid up in hydraulic-cement mortar or of walls made of these materials with a core of concrete. Of late, however, this form of construction has almost entirely given way to reinforced concrete, particularly so in the case of the larger developments. Frequently reinforced concrete dams are of the so-called "gravity" type made hollow and with a sloping upstream side—see Fig. 7—a scheme depending upon the weight of the water rather than that of the dam to secure stability and resulting in a decided decreased cost of construction.

Another type of masonry or concrete dam is that of arch form. This is exceedingly economical of material, but requires the use of abutments substantially secured to take up the thrust.

Wherever possible and especially in the case of masonry and concrete dams, openings fitted with iron gates operated by a rack and pinion or a screw should be provided at top and bottom of the structure, those below for the purpose of allowing drainage of the reservoir and those above to allow for the removal of accumulated trash. Frequently also the law requires provision for log sluices and fishways, the former con-

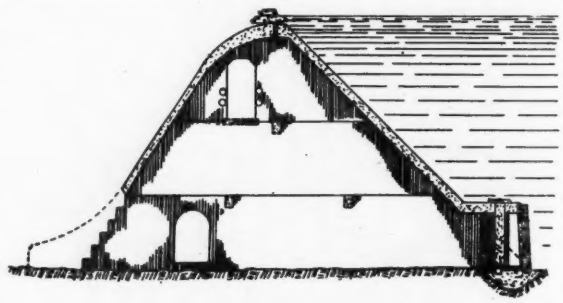


FIG. 7. SECTION THROUGH CONCRETE DAM OF GRAVITY TYPE

sisting of an inclined chute on the downstream side of the dam with a gate at the crest which may be opened at any time the passage of a log drive becomes necessary. A fishway may be of either one of two forms. It may consist of a flight of pools with the water spilling successively from one to the other or of a chute moderately inclined and fitted with alternately right and left side baffles each extending about three-fourths of the distance across the chute.

What will probably become a law is the bill in the Colorado House of Representatives seeking to broaden the powers of engineering examining boards. It passed on its second reading by a vote of 44 to 9. The bill provides for the licensing of all mining, civil and electrical engineers in the state, and provides that they shall have a degree in a recognized technical school and 4 yr. practical experience, or the equivalent, before they shall be granted a license. The bill would exclude all except citizens of the United States from receiving licenses.

That of every gallon of gasoline used in motor cars, nearly 30 per cent is wasted through faulty carburetor adjustment is one of the startling conclusions derived from exhaustive tests of the composition of automobile exhaust gases, by three prominent chemists of the U. S. Bureau of Mines.

Testing Cleanness of Producer Gas

COMMONPLACE APPARATUS SUCCESSFULLY USED IN THE ACCURATE DETERMINATION OF CLEANING EFFICIENCY. BY H. F. SMITH

IN THE manufacture of industrial gas, it is desirable to possess a method of accurately determining the efficiency of cleaning by any of the several methods in use today. While there are in use, several methods for testing the efficiency of these cleaning processes, they are for the most part laboratory methods requiring a high degree of skill, and as a result few tests have been made and very little data is available as to the actual effectiveness of the various cleaning processes.

With the idea of simplifying the process of testing and overcoming some of the difficulties connected therewith, the writer has employed with much satisfaction the following method, which has proved to be sufficiently simple for use by the average plant operative, and is in addition remarkably accurate.

Apparatus and Method of Procedure

A FILTER PAPER holder of any convenient size—say to take a 3-in. filter—and an ordinary dry test meter reading down to 0.01 cu. ft., such as is commonly used by city gas companies to demonstrate gas consumption on various appliances, is all that is necessary in the shape of equipment.

The procedure is briefly as follows: Connection is made to the discharge or clean gas side of the apparatus to be tested, and a sample of gas taken through a clean white filter paper. The filter holder should be placed with the paper horizontal and the flow of gas upward. The connection to the point of sampling should be as short and direct as possible. The weight of flow should be controlled by a valve placed on the discharge side of the filter holder, between it and the meter. If a valve is used in the connection between the point of sampling and the filter holder it must be wide open during the test. With a 3-in. filter paper, gas can be passed at a rate of about 1 cu. ft. per min. A higher rate will probably tear a hole in the paper and invalidate the test. Ten cubic feet of gas should be passed through the first paper which should then be removed, marked with the quantity of gas passed, and laid aside for future reference. A second paper with 20 cu. ft. and a third with 30 cu. ft. should be taken in the same way. The connection should then be changed to the inlet or dirty gas side of the apparatus under test, and a series of filter papers taken starting with 0.01 cu. ft. for the first, 0.02 for the second, and so on. Especial care should be taken on this series not to restrict the flow in any way till after the gas has passed the filter. The connection between points of sampling and the filter holder should also be very short and direct, and the space below the filter should be filled with dirty gas before the filter paper is clamped in position so as to insure the full quantity of gas as indicated by the meter that really passes through the filter. The quantity of gas passed through the second series of papers should be such as to make one of them match in shade one of the clean gas series, and a little experience will show the correct volumes for the condition under test.

Suppose, for example, that the dirty gas paper for 0.01 cu. ft. matches in shade the clean gas paper for 20 cu. ft. This shows that there is as much tar in 0.01 cu. ft. of dirty gas as in 20 cu. ft. of clean gas or 1 cu. ft. of dirty gas in 2000 cu. ft. of clean gas. In other words, 1999 parts of tar have been removed out of a total of 2000, giving a cleaning efficiency of $1999 \div 2000 = 99.95$ per cent.

It should be noted that when the efficiency of the cleaning plant is high, a large volume of gas must pass the filters of the clean gas series in order to produce the depth of color given by as little as 0.01 cu. ft. of dirty gas, and for this reason, the accuracy of the method does not change very much even when very high cleaning efficiencies are being secured. The ease with which the determination is made and the exactness with which the results can be checked by series of efficiency tests even in the hands of an inexperienced operator give confidence in the accuracy of the results.

Required Efficiency of Tar Extraction

A SATISFACTORY method of testing tar extractor performance being available, it is only natural to inquire what efficiencies are necessary or desirable for satisfactory service. Most of the data available relates to the cleaning of gas for gas engine service. Several reports from English sources and covering various well-known types of tar extractors run about as follows:

1. Bubbling washers in which the gas is brought into intimate contact with a washing fluid by being bubbled through it in finely divided streams.

Test No.	Tar at Inlet	Tar at Outlet	Purification, Per Cent
1	11.26	1.54	86.3
2	12.92	1.44	86.8
3	10.5	1.39	86.8

2. Baffle extractors, similar to the well-known "P & A" in which the gas passes through small apertures and against opposed baffle surfaces. Tests reported were on a tar extractor with six plates or baffles.

Test No.	Tar at Inlet	Tar at Outlet	Purification, Per Cent
1	16.86	0.267	98.4
2	15.15	0.302	98.0
3	10.71	0.258	97.6
4	15.21	0.133	99.1
5	12.89	0.155	98.8
6	15.56	0.420	97.3

3. Centrifugal tar extractors or washing fans.

Test No.	Tar at Inlet	Tar at Outlet	Purification, Per Cent
1	3.8	0.426	89.
2	13.8	0.458	96.7
3	26.5	0.69	97.4

Since the above tests were on equipment for cleaning gas for power service, it would seem that 98 per cent cleaning would be considered good average practice for the types of cleaners mentioned, and good enough for gas engine service.

The writer's experience would indicate, however, that for such service a cleaning efficiency of not less than 99 per cent is necessary. Contrary to the usual belief, a well-designed gas engine is not especially sensitive to tar, and will function very well on gas that would be altogether too foul to put into any extensive system of distribution mains. In a gas engine installation the mains between the gas plant and the engine are usually short, the gas delivery pressures low, and velocities of flow moderate.

If we assume, as some have done, that a moderate degree of cleanness is sufficient for fuel gas, and take 95 per cent cleaning as a standard, 5 per cent of all tar produced would pass into the mains. Producer gas yields from 100 to 200 lb. of tar per ton of coal and this would pass 5 to 10 lb. of tar for each ton of coal gasified. On a plant gasifying one ton per hour we would have from 120 to 240 lb. per day, or 18 to 36 tons of tar per year carried into the distribution system. This will plug a lot of pipe.

Relative Values of Cleaning Efficiencies

Recent improvements made in this country, and the development of more effective methods of cleaning than those described make it easily possible to greatly exceed the efficiencies of cleaning mentioned. Recent tests on several installations of large capacity show efficiencies of over 99.9 per cent—frequently as high as 99.98 per cent. This gas is more than 200 times as clean as the gas mentioned in our example above, and can be carried without difficulty in any sort of distribution system.

It may be of some interest to note the significance of fractional per cents of efficiency in cleaning. At first glance the difference between 99 per cent cleaning and 99.98 per cent would seem small and unimportant.

With 99 per cent cleaning 1 per cent or 0.0100 of tar is carried forward. With 99.98 per cent only 0.02 per cent or 0.0002 of tar passes the cleaner. In other words, gas cleaned at 99.98 per cent efficiency is fifty times as clean as gas cleaned at 99 per cent. This involves as great an increase in cleanness as the whole range from dirty gas up to 98 per cent cleaning, which is also a fifty-fold increase in cleanness.—The Iron Age.

The Weight of a Conical Pile of Ashes

By N. G. Near

IT IS often necessary to determine the weight of a pile of ashes, and while this may be easily arrived at by calculation, some time will be saved if the accompanying chart is used for the purpose. The chart quickly gives the weight of any conical pile of ashes, provided the diameter or circumference is known. It is based upon the average angle of repose assumed by ashes and the average weight per cubic foot.

To determine the weight of the pile measure the diameter and glance at the chart and the column B gives the answer instantly. For example, if the diameter of the pile is 20 ft., find 20 in column A. Then opposite the 20 in column B will be found the approximate weight, i. e., 37,000 lb., or 18½ tons. If it is difficult to measure the diameter, step around the pile in three-foot strides and so determine the circumference. The diameter corresponding to any circumference in column C will be found in column A.

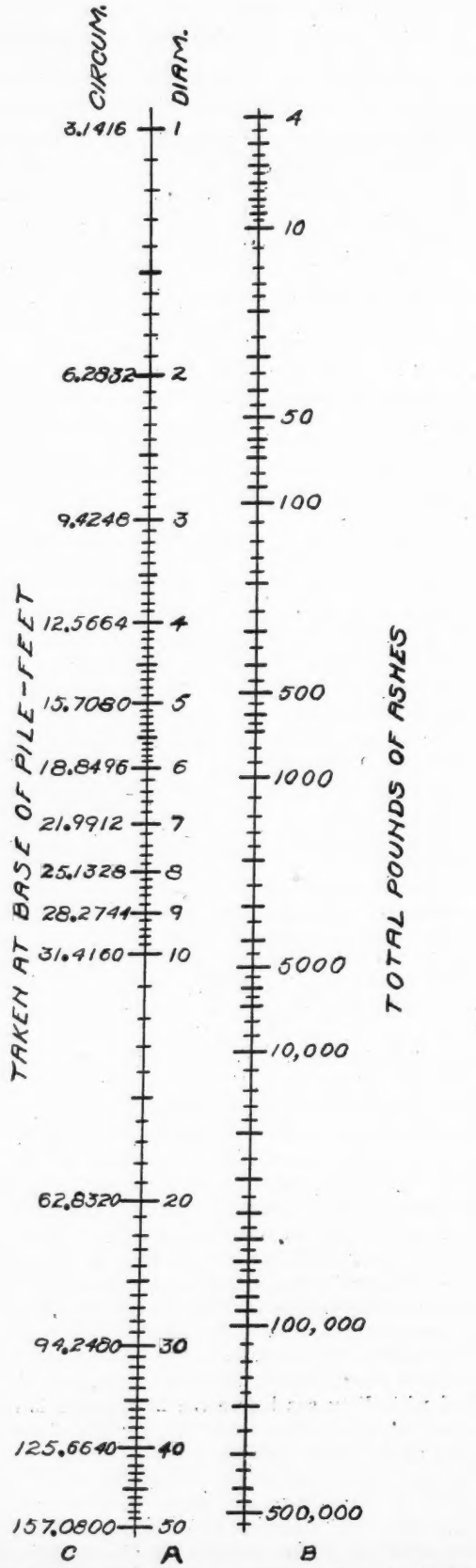
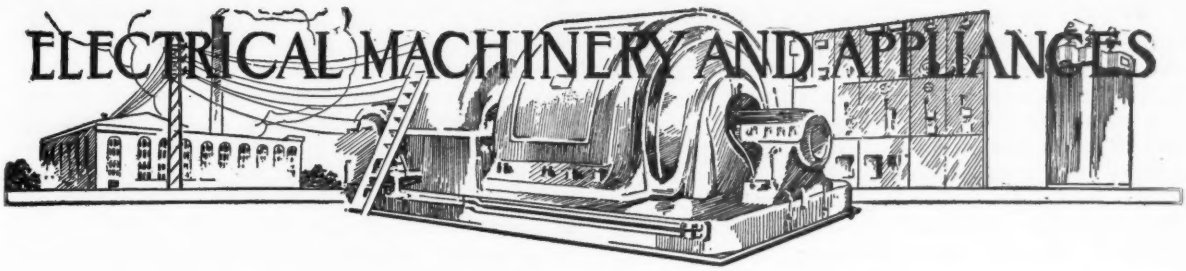


CHART GIVING WEIGHT OF A CONICAL PILE OF ASHES



Remodeling Switchgears for Power Systems---IV

INCREASING CAPACITY OF STATIONS NECESSITATES MANY CHANGES. BY STEPHEN Q. HAYES*

ANOTHER EXAMPLE of the use of a group system proposed for the remodeling of a power system is illustrated in the three following illustrations. The first shows the present diagram with a double-throw system utilizing one breaker with two sets of disconnects per circuit, the second shows the proposed re-connection of the system with a group arrangement of circuits, and the third shows the relative location of the group and feeder breakers.

As shown on the single line diagram of the present 2300-v. layout, Fig. 29, the actual arrangement of the present generating station is such that any generator or any feeder may be connected to either or both of two 2300-v. busses, each circuit being provided with one solenoid-operated oil circuit breaker and two sets of disconnecting switches.

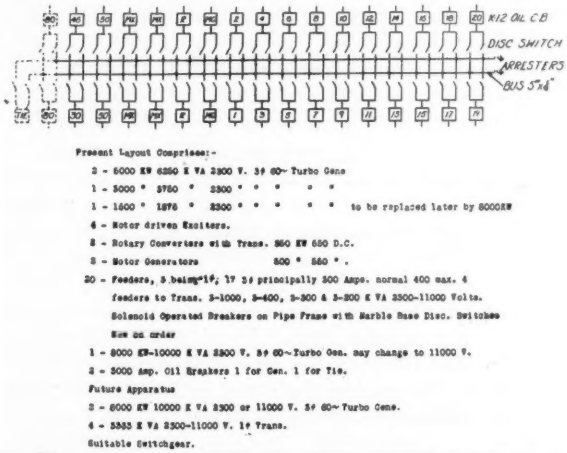

K12 OIL C.B
DISC SWITCH
ARRESTERS
BUS 5"x1/4"
Present Layout Comprises:-
2 - 5000 KW 6250 K VA 2300 V. 3ϕ 60~ Turbo Gens
1 - 3000 " 3750 " 2300 " " " " "
1 - 1500 " 1875 " 2300 " " " " " to be replaced later by 8000KW
4 - Motor driven Exciters.
2 - Rotary Converters with Trans. 350 KW 550 D.C.
2 - Motor Generators 500 " 550 " .
20 - Feeders, 3 being 1ϕ; 17 3ϕ principally 300 Amps. normal 400 max. 4
feeders to Trans. 3-1000, 3-400, 3-300 & 3-300 K VA 2300-11000 Volts.
Solenoid Operated Breakers on Pipe Frame with Marble Base Disc. Switches
Now on order
1 - 8000 KW-10000 K VA 2300 V. 3ϕ 60~Turbo Gen. may change to 11000 V.
2 - 3000 Amp. Oil Breakers 1 for Gen. 1 for Tie.
Future Apparatus
3 - 8000 KW 10000 K VA 2300 or 11000 V. 3ϕ 60~ Turbo Gens.
4 - 3333 K VA 2300-11000 V. 1ϕ Trans.
Suitable Switchgear.

FIG. 29. DIAGRAM OF PRESENT CONNECTIONS, SECOND STATION CITED

The present station comprises the following units: Two 5000-kw. 2300-v. three-phase, 60-cycle, 6250-kv.a. turbo generators; one 3000-kw, 3750-kv.a. 2300-v. 3-phase, 60-cycle turbo generator; one 1500-kw., 1875 kv.a. 2300-v., 3-phase, 60-cycle vertical turbo generator that will later be replaced by a horizontal 8000-kw. 10,000-kv.a. unit; four motor-driven exciters, two rotary converters with transformers each 350 kw. 550-v.; two motor generators each 500-kw. 550-v. d.c.; approximately 20 feeder circuits, 3 being single phase, 17 three-phase, principally 300 amp. capacity normal, 400 amp. maximum.

Of these feeder circuits, four run to transformer banks stepping up from 2300 to 11,000 v. One bank comprises three 1000-kv.a. units, the next three 400-kv.a. units, the next three 300-kv.a. units, and the last three 200-kv.a. units. These transformers are all of the outdoor type located in the switch yard adjacent to the power plant.

For this plant there is now being installed one 8000-kw., 10,000-kv.a., 2300-v., 3-phase, 60-cycle turbo generator and it is considered possible that at some later date new iron and windings of this machine may be ordered to make it an 11,000-v. unit. For use with this generator, two 3000-amp. oil circuit breakers are being supplied, one being intended for generator control and one as a tie breaker.

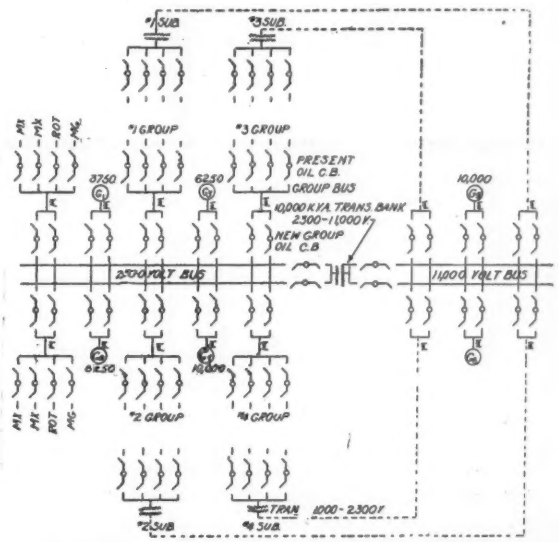


FIG. 30. DIAGRAM OF PROPOSED CONNECTIONS

The future growth of this station contemplates the installing of two 8000 kw. (10,000 kv.a., 80 per cent P.F.) 2300 v., or probably 11,000 v., three-phase, 60-cycle turbo generators; four 3333 kv.a. 2300-11,000 v. single-phase transformers, forming one 10,000 kv.a. bank with one spare.

After investigating various schemes of operation, and considering the advisability of using, if at all possible, the large number of small breakers now in service, an arrangement as indicated on single line diagram, Fig. 30, will prove to be most satisfactory.

*Switchboard Expert, Westinghouse Electric and Manufacturing Company.

With the arrangement indicated, it is the intention to add a double set of 2300-v. bus bars and to arrange that the present 2750 kv.a. unit and the two present 6250 kv.a. units and the new 10,000 kv.a. unit will each connect through two sets of breakers to either or both of these 2300 v. busses, that is, the breakers in question will be of large rupturing capacity owing to the amount of power that may be concentrated on the 2300-v. bus.

From the main 2300-v. bus, current will be taken through breakers to a number of group busses. One of these group busses which may be considered as auxiliary group 1, will take care of the circuit for two motor-driven exciters, one rotary and one motor generator set. The second auxiliary group bus will also control circuit to two motor-driven exciters, one rotary

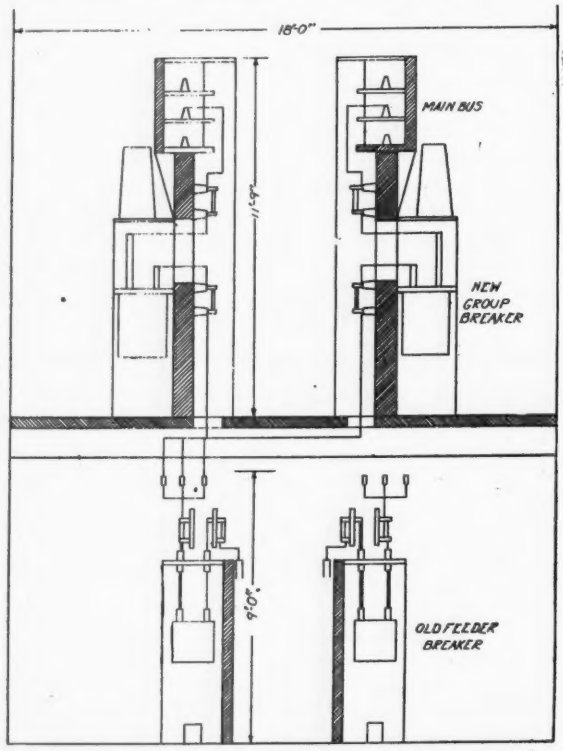


FIG. 31. SECTION THROUGH SWITCHING GALLERIES

converter and one motor generator set. There will be four such breakers for the remaining groups that are marked 1, 2, 3 and 4, each group comprising four outgoing feeder circuits. Connected to this same bus through two oil breakers will be the 10,000-kv.a. transformer bank.

The arrangement indicated shows the present 10,000 kv.a. generator left wound for 2300 v., but arranged so that it can feed out over the 11,000-v. circuit to the 10,000-kv.a. bank. The two new generators will tie into the 11,000-v. bus.

The four 11,000-v. feeders now run from individual transformer banks in the yard adjacent to the power house will be operated from the 11,000-v. bus located in the station. The present transformers or possibly others of a different capacity would then be installed in future substations marked on the diagram as substations 1, 2, 3 and 4. In these substations would be a reasonable number, possibly four, 2300-v. circuit feeders supplied from a common bus.

Another idea considered in connection with the possible installation of substation and transmission at 11,000 v. was the moving of the motor generator sets and the rotary converters to one or possibly two substations in the down town districts in order to supply the direct current elevator load at that point.

Figure 31, "Section through Switching Galleries," shows breakers for the group circuit, each breaker being located in its own masonry compartment with masonry barriers between poles and the main bus located in a masonry compartment. For the group busses, a modification of the present open construction can be utilized to advantage. The busses and disconnecting switches will be located on a pipe framework above the masonry compartment. For the group busses, a modification of the present open construction can be utilized to advantage. The busses and disconnecting switches will be located on a pipe framework above the masonry compartment that are to contain the present small oil breakers.

While the present small oil breakers are operated by solenoids directly in the rear of the breaker, it will be possible to obtain a few bell cranks and rods so that the solenoid mechanism can be located on the floor of the cell compartments approximately as indicated.

With the arrangement of structure shown, the two rows of large breakers with their busses can be located in the gallery 18 ft. wide, although a station designer would normally prefer a slightly greater amount of space so as to facilitate working the tank lifter and hand closing mechanism on the front of the breaker and operating the disconnecting switches on the rear. The head room required for the structure containing the busses and breakers will be approximately 11 ft. 9 in.

To carry out the contemplated arrangement of group breakers to advantage, it will be necessary to replace all of the bellows type relays on the present feeder circuits by an induction relay set to give a definite time limit practically independent of the load. The scheme contemplates setting the relays on the small breaker circuits to trip out in approximately 2 sec. at any suitable overload and to make the group breakers instantaneous for any short circuit condition that will be beyond the rupturing capacity of the small breakers which are capable of rupturing 9000 amp. at 2400 v.

In order to have an ample safety margin, it is probable that the feeder group breakers would be set to trip out instantaneously on any load exceeding 5000 amp. at 2500 v. As the normal current rating of the individual feeders is 300 amp., and there will probably be four feeders on each group circuit, the setting of the relays on the group breaker will be such that four times the combined full-load rating of the individual feeder circuit would be needed to trip the group breaker so there is no likelihood of the group circuit breaker coming out except in such cases that the short circuit conditions would be beyond the rupturing capacity of the small breaker.

The breakers for the group circuit would be 1200-amp., 15,000-v. breakers like Fig. 5, as these can be

guaranteed capable of rupturing 60,000 amp. at 2500 v. If it were desired to use more than four 300-amp. feeders on any group circuit, the 1600 or 2000-amp. breakers could be furnished, these having a guaranteed rupturing capacity of 54,500 amp. at 2500 v.

The width required for the large breaker is 4 ft. 4 in. and if the space requirements are such that a slightly narrower breaker is needed and a smaller rupturing capacity would be satisfactory, a 1200-amp. 15,000-v. breaker with a corresponding 1600 or 2000-amp. size, these having a guaranteed rupturing capacity of 33,600 amp. at 2500 v. can be supplied.

For the circuit of the 10,000-kv.a. generator or the 10,000-kv.a. transformer bank where the normal full load current would be in the neighborhood of 2500 amp., the use of the 3000-amp. circuit breaker which will have a guaranteed rupturing capacity of 150,000 amp. at 2500 v. is intended.

For the 11,000-v. circuits, there will be used 300 or 600-amp., 15,000-v. breakers having a guaranteed rupturing capacity of 10,000 amp. at 15,000 v.; 13,250 amp. at 12,000 v. If the operating company is willing to consider a breaker of smaller rupturing capacity, 300 or 600 amp. breakers having a rupturing capacity of 4500 amp. at 15,000 v., 5960 amp. at 12,000 v. could be furnished.

Third Plant Cited

In another plant that is outgrowing the capacity of its switching equipment now installed in narrow galleries running the length of the power plant, a somewhat different arrangement will be adopted for its reconstruction.

The main generating station contains at present one 2500-kv.a. turbo, one 3750-kv.a. turbo, one 5000 kv.a. turbo, 6600-v., 3-phase, 60-cycle, and a number of 6600-v. three-phase feeders.

One of the three-phase feeders supplies current to three 500-kv.a. outdoor transformers stepping up to 33,000 v., and another feeder controls three 1000-kv.a. outdoor transformers stepping up to 66,000 v. forming tie connections with another system.

Future additions to this steam generating station contemplate the installing of two 10,000-kv.a. units, possibly winding them for 13,200 v.

The present switchboard is equipped with small oil circuit breakers with mechanical control, except that the circuit for the 5000-kv.a. turbine has recently been changed to solenoid control.

The circuit breakers, disconnecting switches and busbars are located on the main station floor while the swithboard panels of blue Vermont marble are located in a gallery. The middle slabs of the switchboard will be changed to take care of mounting control switches in the position now occupied by the operating handles of the present mechanically controlled breakers, as it is the intention to figure on electrical control for the ultimate development. The field switches for the generators will be changed to electrically operated devices to secure automatic tripping in case of emergency. The present installation has a double set of exciter busses, only one normally being in circuit, this exciter bus being controlled by a regulator. The control circuit of the solenoid operated breakers is at present taken from this exciter bus, but this method of operation is not satisfactory, owing to fluctuation in the d.c. voltage when the regulator is in operation. Possibly a storage battery and a motor generator charging set will be installed later.

The rheostats in the generator circuit are chain operated and located above the switchboard panels. Above the gallery containing the switchboard panels is a room known as the pent house that now contains a few lightning arresters connected in the 6600-v. circuit.

The operating company wished to secure breakers of greater rupturing capacity than the present small ones and to arrange for a double set of breakers and busses so that any individual breaker may be inspected and repaired without the necessity of shutting down the generator or feeder circuits.

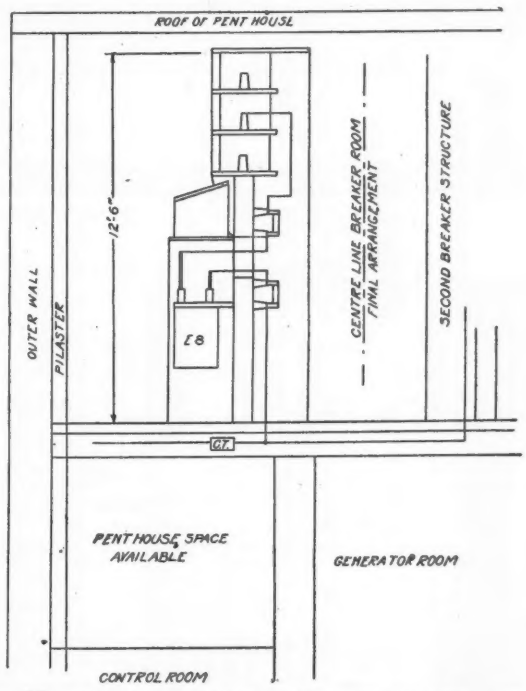


FIG. 32. SECTION THROUGH SWITCHING GALLERY, THIRD EXAMPLE

After considering various possible locations such as installing an additional set of breakers in the cellar, it was finally recommended that the roof of the pent house should be raised, a floor put in at the level of the roof of the present generating station and a switch room built out over the roof. A switchboard room obtained in this manner would be sufficiently large to allow for two rows of breakers and busbars.

As a temporary expedient to be worked into the ultimate installation, now electrically operated breakers for generator and feeder circuits will be installed, a row of these breakers with busses and disconnects being placed in the present pent house. As soon as these are installed, the various generators and feeders will normally be operated on these circuits, the mechanically operated small breakers on the present floor being kept for emergency operation. The general arrangement is indicated in Fig. 32.

While Fig. 32 shows the ultimate arrangement proposed for locating the breakers in the new switch house, it was necessary to provide accommodations for breakers of equivalent rupturing capacity that could be installed in the space available in the top floor of the pent house in a room having a height of 12 ft., a width of 8½ ft. between walls and 7 ft. between pilasters and a length of 64 ft.

Figure 33 shows the plan view of this switch room in the pent house, showing how the breakers are assembled in four groups of four eaeh to avoid interference from the projecting pilasters which are 16 ft. on centers.

Figure 34 shows a section through the pent house switch room utilizing oil breakers having a rupturing capacity of 10,300 amp. at 7500 v. for all of the new equipment. These are arranged for pipe frame mounting on a framework of sufficient height to permit dropping the tank without interfering with the solenoid mechanism. The leads that now connect to the present breakers located on the level of the generator room will be extended upward along the outside wall, the feeders being taken out through the side wall in their present location, a short distance above the floor of the pent house room. A tap is taken from these cable risers just below the floor, the copper strap connections run through the disconnection switch into the oil breaker and thence, through other disconnects, to the overhead bus located just under the roof and running the length of the pent house. Transite barriers are provided between the bus and transite doors are placed in front of the breaker tanks.

Figure 35 shows a front elevation of the breaker and bus structure. The doors are shown on the equipment to the right of the pilaster while they have been removed from that on the left.

Figure 36 shows a sectional view through a portion of the generator station and indicates the location selected for the ultimate switch room. The gallery space allotted for the switching equipment in the original plant proved to be somewhat too restricted for breakers with the rupturing capacity needed for the plant that had completely outgrown the original expectations. Considerable planning was necessary to work out the arrangements that will permit a gradual change-over without shut-down, and will provide an ultimate installation with a complete double set of busbars with breakers of ample rupturing capacity.

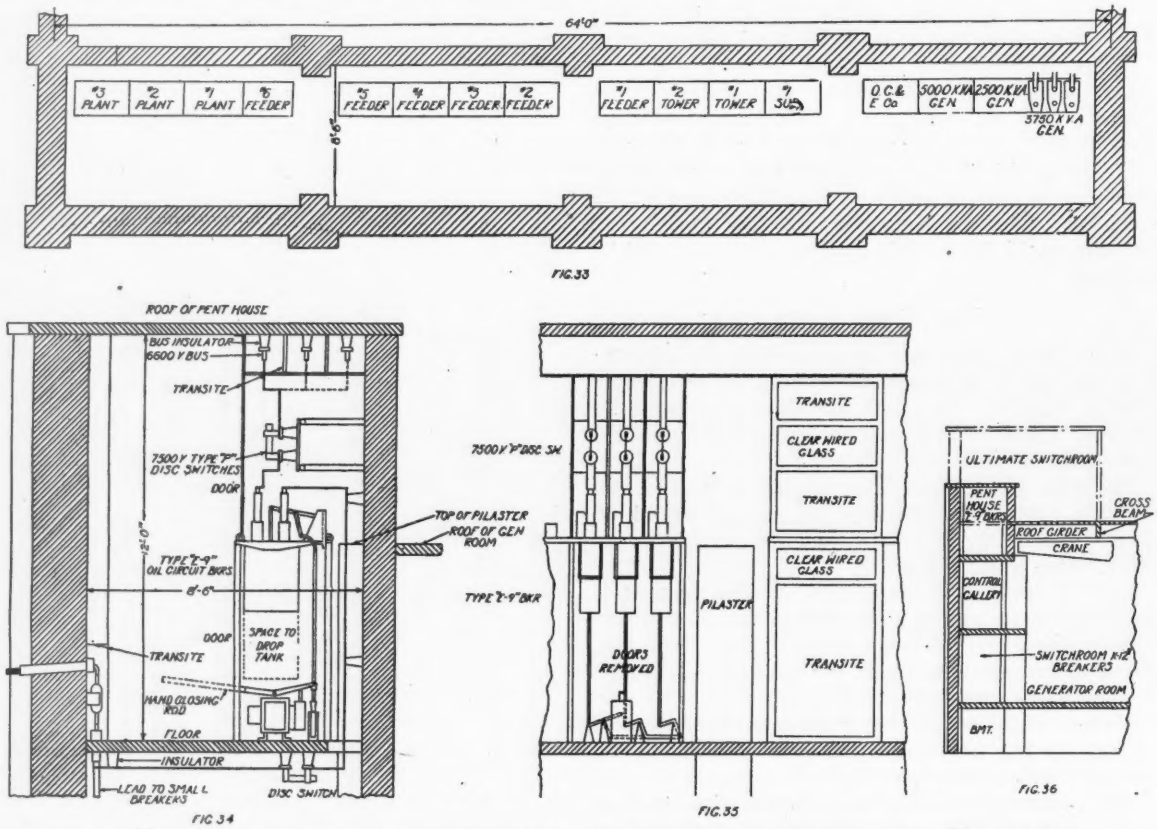


FIG. 33. PLAN OF PENT HOUSE SWITCH ROOM, THIRD STATION MENTIONED. FIG. 34. SECTION OF SWITCH ROOM. FIG. 35. ELEVATION OF BREAKER STRUCTURE. FIG. 36. SECTION THROUGH STATION

There Are Others

EVERYTHING was in ship shape and the chief electrician happened in during the noonhour and passed a few pleasantries with the boys at the power house.

The C. E. observed that Dennis was enjoying the repartee, therefore the Chief asked: "Well, Dennis, did you ever wipe a sleeve?"'

"No, sor. Whinever I drink from the bubbler, I wipe me mouth wid the back of me hand."

Factory Lighting Equipment for Industries

A Consideration of the Advantages to be Gained by Correct Design and the Factors Requiring Attention. By Reginald Trautschold*

WITH such decided gains to be secured by good and adequate lighting as 10 per cent more output, 25 per cent less spoilage, 26 per cent fewer accidents, 25 per cent better workmanship—records which have frequently been bettered—less sickness, decreased labor turnover and 24-hr. utilization of manufacturing facilities when required, the importance of careful and proper selection of lighting equipment for all industrial operations can hardly be overemphasized. When the facts are also taken into consideration that from 25 to 40 per cent of all work in factories and mills is carried on under artificial light, that a small proportion of the establishments throughout the country are really properly lighted—probably not more than 7 or 8 per cent—and that over 100,000 workmen are incapacitated for a period equivalent to a year, each year, simply on account of inadequate or faulty illumination, to say

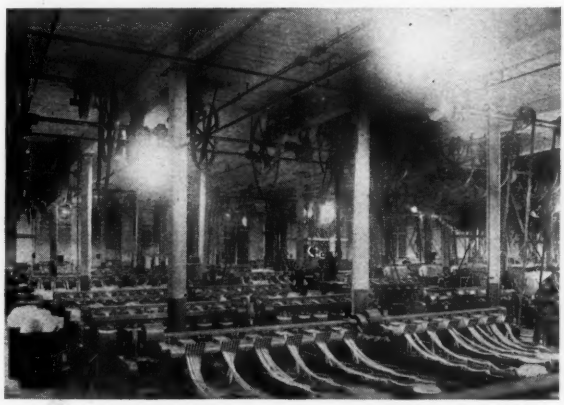


FIG. 1. FOR ILLUMINATION OF THESE COTTON MILL DRAWING FRAMES, DEEP BOWL ENAMELED STEEL REFLECTORS AND 500 W. MAZDA C. LAMPS HUNG 16 FT. ABOVE FLOOR ON 22 BY 33 FT. CENTERS ARE USED

nothing of a monetary loss in the neighborhood of $150,000,000 a year, the importance of proper industrial lighting assumes truly vast proportions.

Planning Systems

To improve lighting conditions in existing establishments and to plan proper lighting systems for new and old buildings (for by the selection of lighting equipment for industries is meant the complete planning of an adequate system of illumination) it is first of all necessary to have a clear-cut objective, to know within close limits the minimum degree of illumination needed for efficient conduct of the various industrial operations. Such values have obviously to be empirically established, and in this connection the standards of illumination expressed in foot-candle requirements listed in the accompanying table are the approved present day standards for minimum illumination requirements in a few of the many industrial activities of the day. As such decided gains have been realized in establishments where these values of illumination have been adopted—values which are materially higher than considered adequate until recently—that the tendency is now to increase still further the intensity of light, hence the qualification of minimum recommended illumination. The values as listed, however, prove quite satisfactory in many instances and well serve as a basis upon which to plan an effective industrial lighting system, for the standard of illumination can be increased to any desired degree by the simple expedient of installing more powerful lamps, once the lighting installation has been correctly designed and the necessary lamp outlets properly located.

STANDARDS OF ILLUMINATION IN FOOT-CANDLES

Occupation or Location	Foot-Candles
Offices, General	10
Drafting room	15
Aisles, stairways, passageways and corridors	2
Store and stock-rooms; Rough	3
Medium	6
Fine	8
Toilet and wash rooms	4
Elevators, passenger and freight	5
Power plants; Boiler, coal and ash handling; Storage battery rooms	3
Auxiliary equipment, oil switches and transformers	5
Switchboards, engines, generators, blowers, compressors	6
Assembling Rooms; Rough assembling	5
Medium	8
Fine	10
Extra Fine	10—50
Inspection, Rough	6
Medium	10
Fine	15
Extra Fine	10—50
Polishing and burnishing	8
Foundries; Charging floor, tumbling, cleaning, pouring and shaking down	5
Rough molding and core making	6
Fine molding and core making	10
Forge Shops; Rough Forging	6
Fine forging and welding	10
Machine Shops; Rough bench and machine work	4
Medium bench and machine work, ordinary automatic machines, rough grinding, etc.	10
Fine bench and machine work; fine automatic machines, medium grinding, fine buffing and polishing	12
Extra fine bench and machine work, fine grinding, etc.	10—50
Sheet metal works; Miscellaneous machines, ordinary bench work, etc.	8

*Of the Society for Electrical Development, Inc.

Punches, presses, shears, stamps, welders, spinning, fine bench work	10
Steel and iron mills; Bar sheet and wire products, soaking pits, reheating furnaces, etc.	2
Charging and casting floors	3
Muck and heavy rolling, shearing, pickling and cleaning	4
Rod, light and cold rolling, wire drawing, fine shearing	6
Structural steel fabrication	6
Textile mills, cotton; Opening and lapping, carding, drawing, slashing, etc	4
Roving, spooling, spinning, drawing in, warping, weaving, dyeing, etc	8
Textile mills, silk; Winding, throwing, dyeing	8
Quilling, warping, weaving, finishing:	
Light goods	8
Dark goods	10
Textile mills, woolen; Carding, picking, washing and combing	4
Twisting and dyeing	6
Drawing in, warping:	
Light goods	6
Dark goods	10
Weaving:	
Lighting goods	8
Dark goods	12
Knitting machines	10
Wood working; Rough sawing and bench work	5
Sizing, planing, rough sanding, medium machine and bench work, gluing, veneering, cooperage	8
Fine bench and machine work, fine sanding and finishing	10

With the advisable degree of illumination known for each room or section of room, the second step in planning a lighting system is to select the type of lighting unit best adapted for the work to be performed and existing conditions. This is largely a matter of choosing the best class of reflecting equipment, for general illumination necessitating the diffusion of the light emanating from the light sources nearly invariably entails the use of reflecting equipment. Where ceilings are dark, semi and wholly indirect lighting is quite unsuited, it is true, but as a general rule reflected light should be employed for the general illumination, to avoid the danger of glare.

Reflecting Equipment

Proper selection of reflecting equipment is governed by several important and quite fundamental considerations. These have been carefully studied by manufacturers of such supplies and the more progressive have rated the various types accordingly, making the selection of the type which will give the best results a simple matter of balancing the advantages and disadvantages and choosing the type which ranks the highest in the aggregate.

Glare is the most serious characteristic of bad lighting and the rating of reflecting equipment in respect to glare has to be given particular consideration. It arises usually from unshaded or inadequately shaded light sources located in the field of vision, or from too great contrast between the bright light source and dark backgrounds or adjacent surfaces. Its avoidance calls for proper reflecting and diffusing equipment. Reflected glare emanates from polished surfaces in the field of vision and is frequently annoying, particularly when the rays of light are reflected from below the plane of vision, as the eye is sensitive to light from below. Illumination of horizontal and vertical surfaces—two fundamental considerations in reflecting equipment rating—are factors which are self explanatory. Shadows play an important part in securing proper illumination and are controlled to a greater or less extent by the type of reflecting equipment employed. They are essential for observing objects in their three dimensions, but are of little value—if any—in the observation of flat surfaces. Though it is rarely advisable to eliminate shadows entirely, they should be soft and luminous, not sharp and dense. Maintenance of the reflecting equipment and lighting unit is another of the fundamental considera-

FIG. 2. IN THIS MACHINE SHOP ABOUT 9-FOOT CANDLES ARE SECURED BY THE USE OF 300-W. MAZDA C. LAMPS EQUIPPED WITH REFLECTOR-CAP DIFFUSERS

tions to be taken into account in rating reflecting equipment and choosing the type of lighting unit best adapted for a particular purpose and location. It depends upon the contour of reflector, construction of lighting fixture and the condition of ceiling. Its rating is based upon the likelihood of breakage, the labor involved in maintaining the units at comparable degrees of efficiency and upon the indication given of need of cleaning.

Manufacturers of reflecting equipment supplying the relative rank of their equipment in respect to these six fundamental considerations, the second step in planning a proper industrial lighting system consists simply in a logical choice of the available equipment—selecting standard types, as far as possible—by weighing the merits of each type as far as the particular installation is concerned and selecting the one which averages up the best for the service desired. It is necessary, of course, for the person planning the installation to know the relative importance of each fundamental as it affects the particular installation and this calls for experience in such matters. For instance, in an office the fundamentals would rank in importance: (1) Direct glare; (2) reflected glare; (3) shadows; (4) efficiency based on illumination on the horizontal; (5) maintenance;

and (6) vertical illumination. In a foundry or engine room, where the lamps are probably hung high to be out of the way of a crane, the order of importance would be: (1) Efficiency, based upon illumination of the horizontal; (2) vertical illumination; (3) maintenance; (4) shadows; (5) direct glare; and (6) reflected glare.

Step three in planning the installation—locating the lamp outlets, the mounting height of the lamps and the number of lighting units required—is probably most conveniently commenced by making a diagram to suitable scale of the floor area of the room under consideration or the portion of the room to be lighted by the contemplated installation. If semi or totally indirect lighting is to be employed, the ceiling height of the room must also be noted for it governs the spacing of the lighting units. If the ceiling height is from 8 to 12 ft., the permissible spacing—distance between outlets—is for the lesser height about 9 ft. and for the greater, about 14½ ft. For each additional foot in ceiling height up to 24 ft., the spacing of the units may be made 1½ ft. greater than the ceiling height. Above 24 ft., the spacing of lamps can be gradually increased until a maximum ceiling height of about 45 ft. is reached with a spacing of about 60 ft.

If the illumination is to be direct, the spacing of lamps may be made equal to their mounting height up to a mounting height of 10 ft.; with the mounting height from 10 to 15 ft., the spacing can be made from 20 to 25 per cent greater; for mountings 15 to 20 ft. high, 25 to 30 per cent greater; with mounting heights of from 20 to 25 ft., 30 to 40 per cent greater and for still higher mountings the spacing may be increased correspondingly. With indirect or direct illumination, the distance between lamp outlets and walls should be made from one-third to one-half the spacing distance.

Spacing of outlets should be made as nearly uniform as conditions will allow. If the spacing has to be made less for a given ceiling or mounting height than has been mentioned, greater freedom from shadows will result but the greater number of lighting units will increase the cost of the installation. If the recommended spacings have to be exceeded, a reduction in mounting height may be possible to compensate for the reduced illumination.

Having located the various outlets to the best possible advantage, the area served per outlet in square feet should be ascertained in order to select with accuracy the size of lamp to place in the lighting units. This consists simply in dividing the floor area of the room in square feet by the number of outlets required. The proper size of lamp depends upon other considerations as well, however, and the accurate determination of these other factors really entails the use of a number of statistical data tables. The depreciation factor, which is a safety factor or allowance for depreciation due to aging of lamps, settling of dirt and dust on lamps and lighting units and deterioration of reflecting value can be estimated. It is usually taken as 1.30 for fairly clean locations and as 1.50 for dirty locations or where cleaning of lighting units is infrequent.

The other factor which has to be determined and which is the one for which the statistical data tables are advisable is the coefficient of utilization, the proportion of the generated light which is really effective. If the ceilings and walls of the room are quite light, the average value of this factor will from such tables be found to be close to 0.44; if only light, about 0.40 and if fairly dark, 0.37. These values, or the more accurate ones to be secured from the data tables referred to, are used, with the depreciation factor, foot-candles of illumination required and the area in square feet served per outlet, to determine the necessary lamp lumen output needed to secure the desired degree of illumination, as follows:

Lamp lumens per outlet = (Foot-candles × Depreciation factor × Area in square feet per outlet) ÷ (Coefficient of Utilization).

The required lumen output calculated, the final step in the selection of lighting equipment consists simply in referring to a lamp list and choosing the size of lamp (wattage) emitting the needed number of lumens.

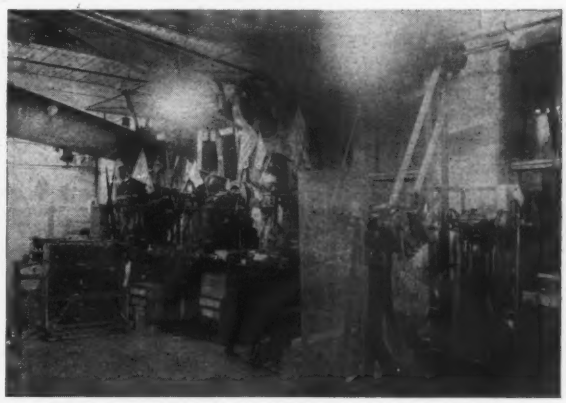


FIG. 3. AUTOMATIC HEEL LOADING AND ATTACHING MACHINES ILLUMINATED BY LOCALIZED GENERAL LIGHTING SYSTEM

The selection of lighting equipment for industries, it is thus seen, entails a simple four-step problem: (1) Decision as to the foot-candles required; (2) selection of type of unit best adapted to the location; (3) determination of proper location of outlets; and (4) selection of proper size of lamp. Planning any and all lighting installations in this manner is no great undertaking and the results will in nearly every instance mean betterments equaling those mentioned in the opening paragraph. The cost of the proper lighting, furthermore, will in no industrial establishment exceed 2 or 3 per cent of the payroll.

WHEN THE Senate receded from its amendment appropriating $10,000,000 for the completion of Wilson Dam for the Muscle Shoals power plant, the chief of engineers instructed that all further construction work be stopped. There is, at present, about $1,000,000 left which will be sufficient for maintenance work until such time as final decision is made as to the fate of the entire project at Muscle Shoals.

BETWEEN 1909 and 1918 the production of crude petroleum in the United States increased 95 per cent, but in the same period, the production of gasoline increased from 13 million to 85 million barrels, or 560 per cent.

The Ice Plant of the Ainsworth Pure Ice Co.

IN A COAL PRODUCING LOCALITY THE PLANT CAN BE OPERATED ECONOMICALLY BY ELECTRICITY AT 3 CENTS PER KW.-HR.

DURING the summer months of 1920, the Ainsworth Pure Ice Co. completed an ice plant in Mason City, Ill., to supply that city, as well as several other communities within hauling distance, with artificial ice in competition with natural ice. Throughout the few months when the plant was in operation last summer, the company was able to undersell natural ice and make a profit.

This plant has a capacity of 20 tons of ice per day and is unique in that it is operated entirely by electricity, thus getting away from the old idea that steam was the only economical source of power for an ice plant. Since the advent of the raw water system, it has paid to look into the possibilities of other sources

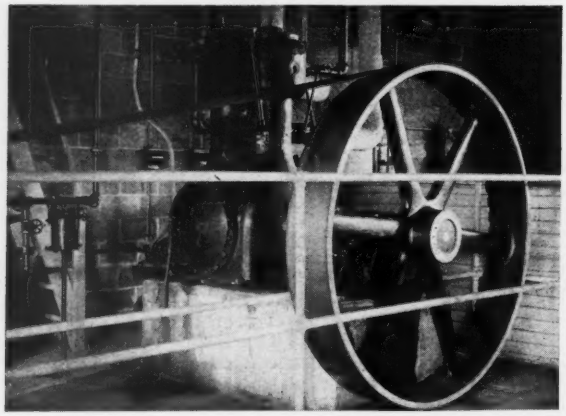


FIG. 1. THE AMMONIA COMPRESSOR BELT DRIVEN FROM A 50-HP. MOTOR

of power, such as electricity or internal combustion engines. The plant uses an aggregate of about 70 hp. in motors which are served by the local public utility lines at a cost in the neighborhood of three cents per kilowatt-hour.

Water for the manufacture of ice and for cooling purposes is taken from a 150-ft. well, in which the surface of the water is 90 ft. below grade, by a plunger pump. This is a walking beam type pump which is driven through reduction gearing and belting from a 7½-hp. motor, Fig. 2. The pump discharges into the settling tank and also provides cooling water for the compressor, the dehumidifier and the condenser. The discharge from these unites, except that the little used for thawing the cans is emptied into the sewer.

In the settling tank, lime is added to the raw water at the rate of 1¼ lb. per ton from a concentrated lime solution kept in a small tank above the reservoir, where it is continually agitated by a set of revolving paddles. A scoop on the paddle shaft discharges a given amount of the liquor into the raw water at each revolution, the speed of the scoop and consequently the rate of discharge into the water being controlled by the rate of flow of water into the tanks, so that the concentration of lime in the raw water is kept constant. On passing from this tank, alum water is added and the treated water then passes to a pre-cooler where its temperature is reduced to near the freezing point. From this cooler, which is served by brine directly from the brine tank, the cold water is introduced directly into the freezing cans through a hose and the regulation automatic can filler.

Air for blowing the cans is supplied by a 6 by 5-in. air pump which is driven by a 7½-hp. motor. Figure 3 shows this pump in the foreground; behind it can be seen the water pump and the dehydrator. The pump delivers about 40 cu. ft. of free air per minute at a pressure of 30 lb. gauge. As the air is heated in the process of compression and as it also contains more than enough water to saturate it at the temperatures to be met with in the brine tank, it is passed through a dehumidifier and cooler, which consists of two well insulated cylindrical tanks in one of which cold water is circulated in a coil of piping and in the other, brine. Air passes through these cylinders, and is cooled, first

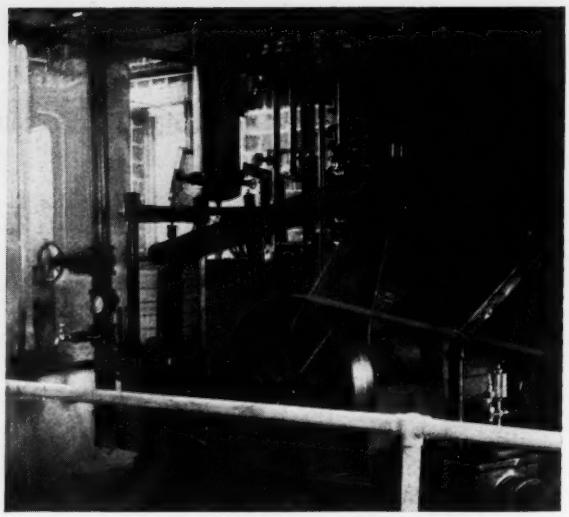


FIG. 2. THE WELL PUMP

by water and then by the brine to a temperature of about 14 deg. At the same time, the moisture content is reduced to that of saturation at 14 deg. which amounts to about 1.11 grains per cu. ft. As the temperature met with in the ice cans is above this point, the humidity of the air will at no time reach saturation, consequently there will be no precipitation of moisture in the air line and no formation of ice in the drop pipes.

Coming now to the main system of an ice plant, that of the refrigerating medium, we start at the liquid ammonia receiver. This tank is located directly under the condenser coils; from it the liquid is allowed to pass through an expansion valve to the brine tank coils and also to the ceiling expansion coils in the storage room. After expansion in these coils, the gas is pulled off at a pressure of from 15 to 20 lb. gage, which cor-

responds to a saturation temperature of from approximately 0 to 6.5 deg. F, by a vertical, two cylinder, single acting, 10 by 10-in. ammonia compressor, a view of which is shown in Fig. 1. The discharge from this machine, at a pressure of 150 lb. gage, is condensed in a double-pipe condenser, Fig. 2, which consists of four stands of 2-in. and 1¼-in. pipe, 12 pipes high and 19 ft. long. From here the condensed gas is returned to the receiver.

The plant is operated in two 10-hr. shifts of one man each. Each shift pulls fifty 400-lb. cans at the rate of five per hour. As is the usual practice, the cans are pulled from alternate rows and from every third column. At the beginning of every hour all five cans are pulled at once and allowed to stand for a few minutes before dumping. The object of this procedure is to concentrate the labor required for the job and to allow the

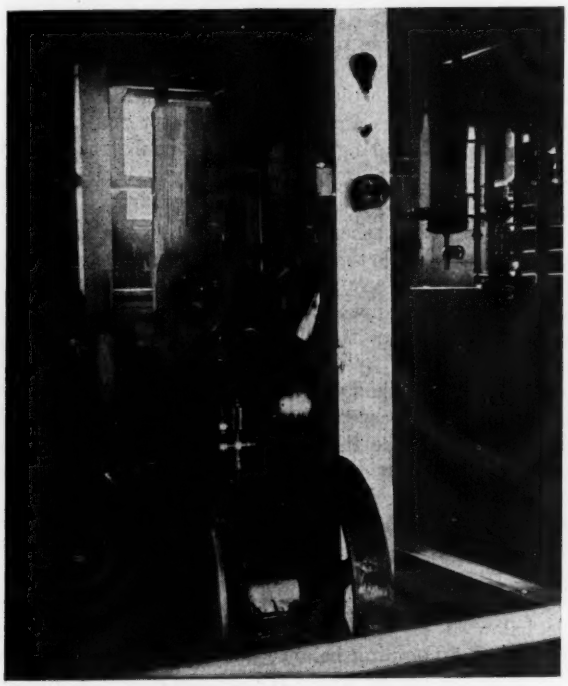


FIG. 3. AIR PUMP, WELL PUMP AND DEHYDRATOR

cans to thaw gradually. By the time the fifth can is pulled the first one is ready for dumping. The can is then picked up again by the crane and carried to the dumping platform. Here it is subjected to a hot bath to finish the thawing process. Although this system requires a double handling of the cans, it is claimed that by following this procedure there is much less loss from cracking and breaking up of the cakes than there is by turning the hot bath on the cans as soon as they are drawn.

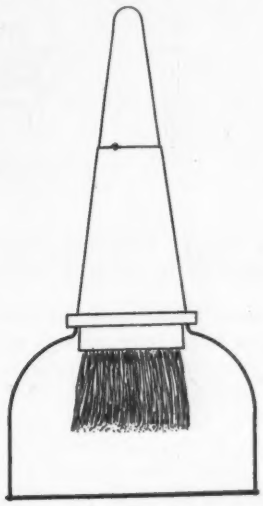
There are 216 cans in the brine tank and as 100 cans are pulled per day, the average freezing time is about 52 hr. At this rate of freezing, a brine temperature of about 12 deg. is required, the temperature varying in practice between 10 and 14 deg.

Considering the power side of the plant, we come to the compressor motor. The compressor is driven at about 80 r.p.m. through a belt drive from a 50-hp. induction motor running normally at 875 r.p.m. This motor as well as all the other motors in the plant operate on a three-phase, 60-cycle, 220-v. circuit.

It has been the experience in this plant that the electrical service has not been perfectly reliable. There have been times when the power has been shut off for a period of as much as a half hour, due to accidents of one kind or another. This condition does not affect the ammonia compressor or the water pump to any serious degree because these units may be shut down for short periods without harm. In order, however, to produce clear ice, it is essential that air be kept blowing through the drop pipe, hence any interruption of the air pump service is to be avoided. To insure continuity of pump operation consideration has been given to the installation of a small gasoline engine that can be quickly hooked up with the pump when the current fails. The consumer demands clear ice and it must be given him so that such an investment will probably be necessary.

Handy Can for Keeping Shellac

SHELLAC is a handy article to have around a power plant, but often the periods between use are so long that the shellac is found unfit for use when wanted. In our plant we have rigged up an old oil can to serve as a shellac can, all arranged so that it can be made and kept



SHOWING USE OF AN OLD OIL CAN AS A SHELLAC CAN

absolutely air-tight. As will be noted on the sketch, the oil can spout is cut off several inches above the screwed joint and then into the taper is fitted a tapered brush which can be tacked in and made air tight by a packing of shellac and which is allowed to dry. When it is desired to use the shellac the top is screwed off and the brush is immediately available with shellac in good flowing condition. The arrangement worked out so well that we used the same idea for pipe thread compound, etc. —B. W., in Refrigerating World.

"THE SWEETNESS of low price never equals the bitterness of poor quality."

Weighed and Found Wanting

IMPORTANCE AND METHODS OF BALANCING PULLEYS, ARMATURES, FLYWHEELS. BY GEORGE H. WALLACE

WHERE is the engineer, or shop superintendent, or whatever title you may apply to the man in charge of machinery, who has not had more than his share of trouble with pulleys and machines out of balance?

Balancing is a fine art and its mysteries are seldom solved satisfactorily. A machine has just been received from a reputable maker, together with its several pulleys and countershafts, and most naturally the purchaser presumes that it is in first-class condition in every way, including balance—even he thinks of balance.

All are familiar with the ordinary lathe, planer, miller, or grinder and their countershafts with anywhere from two to six or eight, or more, pulleys, and clutches on them. The most natural thing is to put the machine in operation just as it arrives at the plant. Later on, vibration is apt to disturb machines or offices on adjacent floors or overhead, to say nothing of unnecessary wear and tear on bearings.

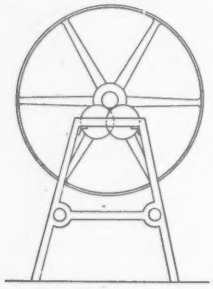


FIG. 1

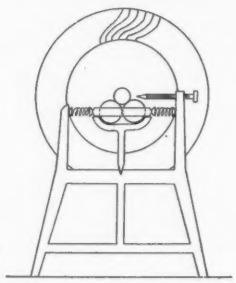


FIG. 2

FIG. 1. PULLEY IN STANDING BALANCE ROLLS
FIG. 2. ARMATURE IN RUNNING BALANCE ROLLS

The writer once installed a machine, on the countershaft of which were four pulleys with the familiar little cast-iron counterweights riveted to the inside of the rims. The machine was badly needed and was put onto production as soon as belted up and started.

The vibration of the countershaft was so excessive that bearings heated, were pounded loose, and bolts and shifter brackets loosened up. There was nothing to do but take the shaft down. It was stripped and each pulley placed independently in a balancing roll when it was revealed that not only were the pulleys badly out of balance but the little weights that had been riveted on were all exactly the same weight and in no instance were they found to be in the right place when removed.

Each pulley was balanced separately and the clutches as well, and reassembled. It was found to operate absolutely without vibration and naturally the bearing remained cool. Since then every machine is looked over and all pulleys are tested for balance wherever possible before erecting. The results are surprising. Very few pulleys or wheels were found to be in balance but after rebalancing and placing in operation I have yet to have any case of trouble.

There are a large number of machines in this plant and a former administration "willed" me some very aggravating cases. Some of these machines could not be spared short of a general wreck, but a little judicious overtime cured many a heart-breaking case. One machine, a No. 9 blast fan, 1700 r.p.m., was a problem. I was informed by one of my men that this fan had melted out a bearing (2⅝-in.) once every two weeks on an average in the three years he was there.

New oilring bearings were secured and the next time this fan went democratic, which was on a Friday, we blew it out with a hose, washed the year's accumulation of grease and dirt off with kerosene and put in new bearings.

It was impossible to take the fan out of the housing to balance the rotor accurately, but we did the best we could by laying two pieces of 1-in. cold rolled steel level across the bearings and let the fan shaft roll on them. On account of bearing studs the fan could rotate only about a third of a revolution, but by a little shifting we soon found the heavy side of the fan.

A bolt with washers was attached to the light side and a few trials brought the desired result, as the fan "stayed put" at any place. A substantial weight was put on in place of washers and the fan runs perfectly smooth, something it had not done for a number of years.

Sometimes it shows signs of being out of balance, but an air hose soon loosens the dirt unequally accumulated. In two years since the change was made, a shut-down was necessary but twice, and then on account of the oil pipe being accidentally broken and letting the oil trickle out, leaving the bearing dry. Spare bearings were inserted in each case in a few minutes and confidence restored.

A revolving pulley, armature, crank, or drum, can be balanced in two ways, either standing or running balance. A standing balance is all that is necessary on the ordinary pulley where the counterweight is applied to the center of the rim.

A short shaft of the proper diameter is used, or the shaft the pulley is to run on if convenient, and the shaft placed in a set of balancing rolls (Fig. 1) which consists of two pair of hardened steel (preferably) disks running on cone or ball bearings. The idea is to have the outfit as near frictionless as possible.

The heavy side of the pulley will always come to rest at the bottom and by clipping pieces of sheet lead over the rim on the light side in varying weights, you can soon find a point where the wheel or pulley will "stay put" or at rest wherever you stop it. It but remains to rivet or bolt to the rim a weight equal to the combined weight of your little clips.

While iron, both cast and wrought, is often used, the writer prefers lead or scrap babbit weights, being about 40 per cent heavier than iron in proportion to volume. Alloy weights should be cast a trifle heavier than necessary and after riveting in place can be chipped a little at a time until a perfect balance is

secured. An oil boat off a bearing makes a good mould to cast counterweights in, or a croquet ball or other similar substance partly imbedded into a box of moulding sand also makes a good mould.

It is better to attach the counterweights with cap screws or rivets as the former can be smoothed off flush and slightly riveted.

A running balance is the only way to balance any lengthy or bulky revolving substance, such as a tractor or auto crankshaft, a d. c. armature or anything similar. Manufacturers of these devices have a "running balance" outfit which consists of a set of rolls in each bearing that look like a roller skate upside down with the wheels close together, Fig. 2. The bearing device stands on a pedestal of half inch steel 5 or 6 in. long, with springs leading sideways. From a stationary part of the main frame projects an adjustable brass point like a lead pencil for each bearing. A small motor rotates the part to be balanced at a speed of 150 to 250 r.p.m. or whatever is necessary, and any difference in balance will cause the bearings to oscillate sideways where the brass point can be adjusted just to touch the bearings where it cuts a little streak in the prussian blue that has been lightly applied. Knowing the "high points," the proper counterbalance can be applied to the right place so that there will be no oscillation at fairly high speeds.

The writer has had two armature cases that stand out above others and are cited here as examples of trouble and applying the proper remedy. Several years ago, on taking charge of a new "one man" plant, it was found that the generator was of the small high-speed type, bolted directly to the floor. The generator was started by "flipping" a 4-in. belt onto a 56 by 4-in. pulley on the line shaft—quite a trick as I discovered—without slowing up. The promptness with which the generator "juiced up" was exceeded only by the promptness with which the tools on the floor began to walk away. The vibration was terrible and it was impossible to stand beside the machine on account of it. The oldest employe said it had always acted that way.

Next morning the armature was removed and placed on two level parallel pieces of round steel on a pair of horses. It promptly settled to rest and it was found that there was an excess of solder on the bands on one side. This was melted off into a paper on the floor and weighed and indicated four and a half ounces. Still that spot stayed down persistently. Then the solder was applied to the bands on the light side and 4 oz. more before a state of equilibrium was established. That night the generator ran perfectly smooth and quiet.

In the other instance a 50-hp. d.c. motor had a bad habit of hammering its pulley bearing loose every three to six months. The pulley was found in balance, and when the armature was removed the last time it was given a standing balance test, as it was too large for the running balance machine. It showed heavy on one side with two little attached castings on the light side. Pieces of lead were added until a perfect balance was secured. The combined weight of the lead and iron was 3 lb. and 3 oz. Question: If you have a piece of a scrap copper bar 17¼ in. long that weighs 5 lb. 7 oz., how long a piece do you need to be used as a counterweight, weighing 3 lb. 3 oz.? Reduce the two weights to ounces and the inches to quarters for convenience and the problem will work out like this:

$$\frac{3 \text{ lb. } 3 \text{ oz.}}{5 \text{ lb. } 7 \text{ oz.}} \times 17\tfrac{1}{4} = \frac{51}{87} \times \frac{69}{4} = 10.11, \text{ or } 10\tfrac{1}{8} \text{ in.}$$

When cut off, the piece weighed within half an ounce of the required weight.

This bar was bent into a rainbow shape and fastened to the end of the armature spider at the pulley end with two cap screws and the result was about as good as could be done with a running balance in a balancing machine.

More frequently than is suspected, machines and engineer are condemned unjustly simply because revolving parts are out of balance. Too much care cannot be taken to secure proper balance. The writer was required to install a lineshaft and a crankshaft of 2 7/16-in. cold rolled steel in a skeleton constructed wood building to run at 305 r.p.m. from which were belted through large cast-iron pulleys, a number of saws, planers, borers, stickers, gainers, etc. Though every pulley was new and presumed to be in balance, there was just one out of 12 that required no changing; some were out of balance as much as 4 lb., which, on a 48-in. pulley, means considerable vibration. As it is, the vibration of the building is hardly perceptible under any operating conditions and wear on the lineshaft bearings is perfectly normal.

On a certain balance set or booster with a flywheel attached, excessive vibration was noted. As the balancewheel was solid and machined throughout, it was believed to be in perfect balance and the trouble looked for in the armature; however, upon giving the wheel a standing balance, it was noted that the metal was denser on one side than the other and threw it out of balance. A few holes drilled into the rim of the heavy spot soon balanced it and the balancer ran perfectly.

A Will, a Way

By J. B. Dillon

SAME old story: if we want a thing and want it really, honestly and truly, or in common parlance, "if we want it bad enough," a way will be found—if our desire is within reason.

The firm had the coal. Customers wanted it, and the firm wanted to sell them, but what prevented the consummation was the lack of transportation facilities.

Somebody thought over it at length and suggested the motor truck. Many were of the opinion that owing to the ruggedness of the topography the truck could not accomplish it.

"How do we know? Let's try it. We are not trying the impossible."

That was a short while since, and now the coal mines near Cedaredge, Colo., are producing coal in quantity for the first time, due to the advent of the motor truck, and the folks in the valleys are happy.

There are times when you will be unable to secure railroad cars. Don't overlook the value of the auto-truck. The "old boat" has created good business in many hamlets where there was none before, and she is able to reach almost any place that has the semblance of a marginal road.

Explosion in High-Pressure Air Line

By E. D. Gardner

AN EXPLOSION occurred in a high-pressure compressed-air line in October, 1920, at an Arizona copper mine. The explosion was unusual, and nothing had been noted by the plant operators to indicate the possibility of such an occurrence.

The mining company uses compressed-air locomotives to haul about 4500 tons of ore per day from the stopes to the pockets at two hoisting shafts. The ore cars hold five tons each, and are pulled in trains of 20 cars. It is necessary to charge the locomotive with compressed air at both ends of the trip. The air is conveyed from the compressors at the surface to the distributing points underground in special high-pressure 4-in. steel pipe that was tested to withstand 2500 lb. per sq. in. before being installed. The air is delivered to the locomotives at a pressure of 1000 lb. per sq. in. There are no receivers in the system.

The air for running the locomotives is compressed by one three-stage and two four-stage compressors which have capacities of 600 and 300 cu. ft. per min., respectively. These machines are operated by electric power, and are in an end of the main compressor building in which air is compressed to supply the air drills in the mine.

Whenever the demand decreases, as at the noon hour, one or more of the compressors are shut down. On this particular occasion, at the end of the noon hour, one of the operators was approaching the high-pressure compressors to start the two smaller machines that were not running, when the explosion took place under the floor a few feet ahead of him. The man was knocked down and received some superficial cuts and bruises, but was not seriously injured. The floor was torn up, the side of the building blown out, and holes knocked in the roof some 20 ft. above. The explosion was immediately followed by a fire which was quickly put out by the plant operators with hand fire extinguishers.

At the time of the explosion, the 600-cu. ft. compressor was running alone, and the pressure in the system at the machine registered 1040 lb. per sq. in. On examination, it was found that two 8-ft. sections of pipe, about 10 ft. apart, were completely ruptured into twisted fragments; the rest of the pipe line, apparently, was not injured. The destroyed sections were in that part of the pipe near the large compressor and above the connection from the two smaller machines. It is not definitely known what caused the explosion.

Explosions in other compressed-air systems have taken place, and, although of rare occurrence, have caused loss of life. Such explosions are not confined to high-pressure installations and several have occurred at plants compressing air to 100 lb. per sq. in. or less. Explosions of this nature are not to be confused with the rupturing of compressor cylinders from excessive air pressure caused by the discharge valve being closed.

Causes of Explosions in Compressed-Air Lines

A number of theories have been advanced to account for explosions in air lines, but there is not enough evidence to state positively that any one condition is responsible, and it is possible that there are a number of contributory causes.

To obtain a gas explosion, two conditions are necessary; first, an explosive mixture, and, second, something to set it off. Enough oil must be fed into the cylinders of an air compressor to lubricate properly the moving parts, and in order to insure this an excess is used which may accumulate somewhere in the system. When oil is fed into the cylinder it is partly vaporized by mechanical action of the air. The quality of the oil used has an important bearing on the operation of the compressor, and is probably the most fruitful cause of explosions in receivers or air lines.

Apparently all cylinder oils are carbonized to some extent in the compressor cylinder, and, if the poorer grades of cylinder oil or those not adapted for the purpose are used, large deposits of carbon may accumulate in the air lines or receivers. This carbon is inflammable, becomes oil soaked, and is always a source of danger. Heated air from the compressor may cause the carbon to burn and thus vaporize the deposited oil in sufficient amount, together with any coming from the compressor, to form with the compressed air an explosive mixture. This mixture may then be exploded by the hot air, or, more likely by a glowing point of carbon.

The temperature of the air in air compressors increases with the ratio of compression. The temperature at the end of the piston stroke in a single-stage machine, compressing to 100 lb. per sq. in. is 425 deg. F. above the intake air. In a 100-lb. two-stage compressor with no intercooling, the increase of the air temperature is 180 deg. for each cylinder. The final temperature of the air at the discharge end of the last cylinder of a three-stage machine compressing air to 1000 lb. per sq. in. would be about 1280 deg. if the air enters the compressor at 60 deg. and no heat is lost by radiation.

The flash point of a series of paraffin-base compressor oils listed in a pamphlet issued by the Ingersoll-Rand Co. varies from 375 to 500 deg. and the firing point, from 425 to 575 deg. The flash point of a series of compressor oils with asphalt base varies from 305 to 375 deg. and the firing point, from 360 to 404 deg.

It will be noted there is only a small margin between the temperatures generated in the cylinders and the flash and the firing points of the lubricating oils. Under high pressure the flash point would be lowered.

Even if the oil vapor would not explode at the firing point, as held by some writers, an oil accumulation may start to burn which in itself might supply sufficient heat to cause an explosion.

It seems likely, also, that an explosion in air lines could be brought about by the compressors being out of adjustment and the heat in the compressed air building up to a dangerous point.

Leaky valves in compressors are dangerous, and are held by some compressor men as generally being responsible for overheating the air. In some types of compressors, the discharge valve in the last-stage cylinder may not be tight, due to carbon deposits or some other cause, and a small part of the heated air may be drawn back into the cylinder with each stroke and be re-compressed. There is a difference of opinion, however, as to whether a leaky discharge valve can result in excessive

overheating of the compressed air. Theoretically, the air leaking back would cool to the temperature it was in the cylinder before being compressed; but it appears that, due to the churning motion of the piston and other heated moving parts, the temperature may build up sufficiently to vaporize the oil and cause an explosion.

Ordinarily, the heat is effectively absorbed in high-pressure installations by a water intercooling system, but any stoppage or restriction of the water-flow would allow the temperature of the air in the compressor to increase rapidly to a dangerous point.

In some types of compressors, it is possible for the temperatures to build up when the air is not being used, by excessive unloading of the machine if a small leak of the cylinder is in a vacuum. A small leak in the valve occurs in the throttle unloading valve. With the compressor running and the valve closed, the intake side would permit some air to enter the cylinder, but it would be below atmospheric pressure. As the increase of temperature in the air varies with the ratio of compression, excessive heating is possible in this case. For example, under the above conditions, by assuming that the pressure in the intake side is 5 lb. per sq. in. and the compressor is furnishing air at 105 lb. pressure, the ratio of compression would be 21 to 1 against 7 to 1 under normal conditions. Most modern compressors, however, are equipped in such a manner that any air compressed under the above conditions is discharged to the outside atmosphere with no ill effects.

An inefficient oil trap may contribute to the explosion by permitting an unusually large amount of oil to leave the compressor with the air.

Oil may burn in the pipe line and cause no damage, or a small explosion may take place with not sufficient force to rupture the pipe line, and carbon monoxide may be generated in the line. It is reported that men have lost their lives from carbon monoxide coming through the compressed-air line to the working face of a drift.

Recommendations

To prevent explosions in air lines, the first consideration is to use the proper grade of cylinder oil, and, second, the compressor valves and intercooling system should be kept in good order. An aftercooler would appear desirable in high-pressure installations. Care should be taken that only fresh air be drawn through the intake of the compressor.

The writer is indebted to Professor W. S. Weeks, of the University of California, for helpful suggestions made during the preparation of this article.—U. S. Bureau of Mines, Reports of Investigations.

Washington offices of the Federated American Engineering Societies were moved to the National Savings and Trust Co. Building at 15th St. and New York Ave. March 21. A suite of eight rooms has been leased on the third floor which in addition to the regular executive offices will contain rooms for the use of members of all constituent organizations with such special facilities as they may want placed at their disposal. This is to be the Washington home of engineers and the Executive Secretary is anxious to have suggestions as to how it may be made of the greatest utility to members.

Collapsing Strength of Iron Pipes and Tubes

By W. F. Schaphorst

THIS chart is based upon the formula given in a number of handbooks.

$$P = 9{,}600{,}000 \frac{T^{2.18}}{L\,D}$$

where P = the collapsing pressure in lb. per sq. in.
T = thickness of metal in inches;
L = length of pipe in inches;
D = outside diameter of pipe in inches.

This chart is intended for use wherever piping is subjected to an external pressure which has a tendency to collapse the tube or pipe.

It is convenient because it does away entirely with computations. Simply lay a straightedge across the chart twice and the result is found.

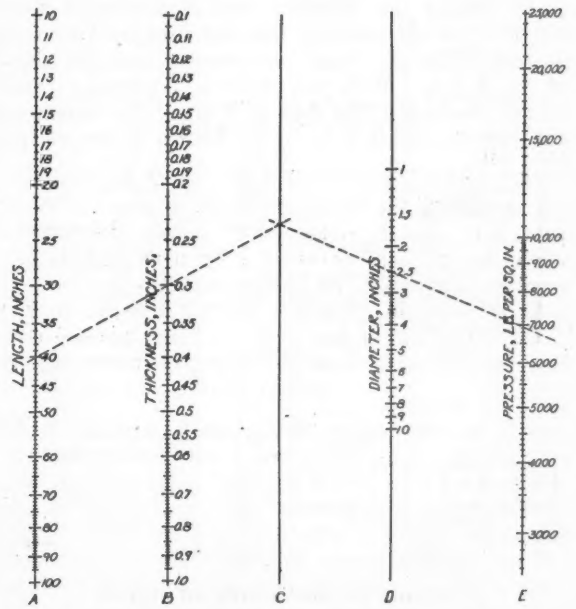


CHART FOR DETERMINING COLLAPSING OF IRON PIPES

The dotted lines, for example, solve this problem:

What external pressure will a 2.5-in. pipe safely withstand whose length is 40 in., and whose thickness is 0.3 in.?

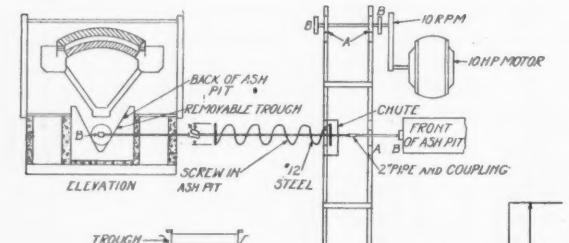
Run a straight line through the 40 (column A) and the 0.3 (column B) and locate the intersection with column C. Then from that point of intersection run through the 2.5 (column D) and the intersection with column E gives the result—about 6950 lb. per sq. in.

The chart can be used with equal ease for determining any one of the factors—length, thickness, diameter, or pressure—where the other three are known. Thus if we wish to determine the thickness of pipe necessary to withstand a pressure of 6950 lb. per sq. in., where the pipe diameter is 2.5 in. and the length 40 in., the same dotted lines would show the thickness (column B) to be 0.3 in.

Solution of an Ash Handling Problem

IT HAD BEEN a question for some time how the ashes could be removed from the pits of three side feed furnaces, by some mechanical means that would not require manual labor. It was almost impossible to install a steam jet conveyor on account of the pits being lower than the level of the river that passes the plant. At times when the river rises, the water will come in faster than it can be pumped out and rise in the ash pits from 3 to 6 in.

In looking the situation over, I discovered about 200 ft. of an old conveyor that had been used for some purpose when the plant was erected, and five sheets of No. 6 iron. With this material I started to make an ash conveyor. The floor in front of the boilers was cut down to within 8 in. of the bottom of the ash pits



DETAILS OF ASH CONVEYING SYSTEM

and 3 ft. wide. Four places were cut in each side of the trench to place the bearings that held the sprocket shafts which carried the conveyor. The conveyor to the ash pit receives the ashes from a chute that delivers it to a pit 12 in. below the conveyor in front of the boilers. There is water in this pit at times which cools the ashes and settles the dust, and does not hinder the operation. This conveyor is fastened to the side of the ash bin, which is made of wood, by four brackets, two at the top and two at the bottom, on which the bearings are placed to hold the top sprocket shaft, and the bevel gear and sprocket shaft on the bottom. The ashes are delivered to the bin at the top by the buckets dumping into a chute. The drive gear extends 18 in. through the wall of the boiler house. All shafting is 1½-in. cold-rolled except the main shaft and the gear shafts which are 2 in. A trough is made to be removable from the ash pits; three screws were made of 2-in. pipe and No. 6 steel. A 2-in. pipe coupling is placed on the screw shaft so as to disconnect the shaft when it must be removed to repair any of the parts of the grates or screw. The screw is driven by a sprocket which is fastened to the end between the top and bottom of the conveyor. It is held in place by a bearing in the back and front of the ash pit. The ashes are delivered to the conveyor on the bottom from a small chute. The whole apparatus is driven at a constant speed of 10 r.p.m. by a 10-hp. motor.

The accompanying sketch will give a clear idea of this installation. C. J. MILLER.

Lubrication Knowledge

ALTHOUGH somewhat late, I desire to make a few comments relative to the subject of "Lubrication," as outlined by J. W. Shaw under the title, "What Do You Know About Oil?" page 189, in the February 1 issue of Power Plant Engineering.

The picture Mr. Shaw draws for the reader is not exactly true to nature, nor is it borne out in fact and in every-day practice. His aim is to encourage engineers in charge of power plants to become experts in lubrication. This would be good if it were always possible, but it is not generally so. The plant engineer has not sufficient opportunity to become an expert in lubrication engineering, for that is a specialty that requires considerable knowledge of the preparation of lubricants, and also research work, which is not within the realm of the plant engineer to engage in.

Before selecting lubricants for any given machine, group of machines, or a plant as a whole, an analysis must be made of all the conditions, in which certain factors are involved.

For example, for the correct lubrication under dry steam and wet steam conditions of large and small engines, the following factors must be analyzed:

(1) Size—diameter and stroke.
(2) Pressure of steam used.
(3) Quality of steam—wet, dry or superheated.
(4) Load carried—full rated load, under load, or over load.
(5) Speed, r.p.m., and piston speed.

These factors analyzed are of more consequence than any set of specifications relative to flash point, viscosity, gravity, etc.

Oil specifications are useful in the manufacture of oils, for the principal purpose of maintaining uniformity of product. It is quite possible for two different oils to have the same specification readings, and yet not give the same degree of service, simply because the original stocks from which the two oils were made, were not the same. Thus it may be seen that specifications do not tell the

whole story. It is service value that is sought, and service value can only be obtained through analysis of operating conditions.

Not only is it important to obtain the correct lubricant for any given machine, or plant as a whole, by the process just described, but it is equally important that the lubricant be properly applied. Merely "putting on oil"—as so many engineers seem to think—is not all that is required, if the best results are to be obtained.

Correct lubrication in its various phases is a science, and it is a special branch of engineering, that requires just as much care, study and research as does any other branch of engineering. Therefore, specialists must take the lead, and those who wish to know more about the subject will be willing to follow, until, at least, they too may class themselves with experts.

The foregoing is written in the spirit of helpfulness and the furtherance of correct basic principles, and not at all with the desire to discount Mr. Shaw's ideas of the need for the plant engineer to become better posted on the subject of lubrication. But the way to become better informed is through the agencies that I have mentioned in this letter, viz.: co-operation with those who know, rather than to go it alone.

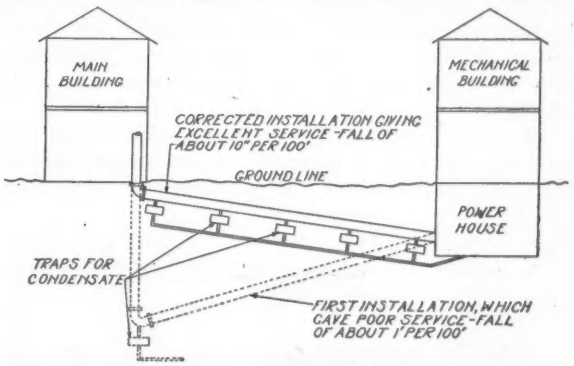
CHARLES J. MASON.

Improving a Heating System

I AM GOING to attempt to describe to you some of the work that I am doing now in our efforts to modernize our power plant. This plant has one 150-hp. Atlas water-tube boiler in fair condition, one 150-hp. return tubular boiler in good condition, one 50-hp. engine in good condition, one feed-water heater and purifier in good condition, one hot water tank 1000-gal. capacity in good condition, one 10-kw. d.c. generator in fair condition, switchboard for it, one vacuum pump in fair condition, one new vacuum pump, two boiler feed pumps in good condition (there are four different makes of pumps in our plant and the reason for this is that the students may become acquainted with more than one make, and if I am here when it becomes necessary to purchase another pump, I will select some make that we do not possess), several hundred feet of steam, water and gas pipe, several hundred feet of electric light wire, with other accessories. This plant supplies heat for the main building of the school, the two dormitories, the mechanical building and for experimental purposes, power for machine-shop, the carpenter-shop and for experimental purposes and electricity for experimental purposes only.

For several reasons, this plant has not been very efficient in its operation and I shall attempt to show what changes have been made and the results therefrom. The main line pipe is 6 in., three-fourths the distance from the mechanical building to the main building and 4 in. the rest of the way; the entire distance covered by the pipe line is 240 ft. and for this distance the pipe had a fall of about 2 in. away from the power house which caused the condensation to flow along in the same direction with the steam and the vacuum pump was to draw this water out when it reached the end of the line, but for some reason this did not happen as it was planned and there were several kinds of trouble that are common to such faulty installations, such as non-circulation of steam, the annoying and dangerous water-hammering and, of course, no heat.

This condition obtained for several years and it was finally decided to make the necessary changes that would bring the plant up to an efficient standard and I was given the job. The first thing that was to be done was to raise the pipe line so that the condensation would not travel to the other end of the line. This was accomplished after a few months' work and traps put along the line to take care of the condensate in order that it would not travel the full length of the pipe in the opposite direction to the steam, the pipe was raised so that the inclination was 10 in. to the 100 ft.; the lower end was at the boiler room and a trap was on the tee there as well as along the line (see sketch) and the vacuum pump was to draw this water out of the line all along the pipe, and it did it and is still doing it. There is no water hammer, there is no blocking of steam and there is heat. Before this change was made, it took from 20 to 40 min. to get steam to the building after it was turned on at the power house and the vacuum pump running, and


MAIN BUILDING
MECHANICAL BUILDING
CORRECTED INSTALLATION GIVING EXCELLENT SERVICE-FALL OF ABOUT 10" PER 100'
GROUND LINE
POWER HOUSE
TRAPS FOR CONDENSATE
FIRST INSTALLATION, WHICH GAVE POOR SERVICE-FALL OF ABOUT 1" PER 100'

ORIGINAL AND REVISED PIPING FROM POWER HOUSE TO MAIN BUILDING

when it did finally reach and warm the buildings it was a problem to keep it on because it fell so rapidly; it would fall from 80 to 30 lb. in 30 min. with the fireman doing his best to keep it up. Sometimes it was necessary to cut the steam off in an hour after it was turned on in order to raise it again and this when the boiler was in good clean condition. Now in 10 min. after the steam is turned on, the buildings are warm and getting hot and in 20 min. the buildings are hot and this without the pump pulling any vacuum at all, in fact not running, and when the pump is running the effect takes place in half the time. This has been in operation for 4 yr. now and has given entire satisfaction in every way; the boilers are easier to fire, less fuel is burned and the service is more prompt; the steam on the line was never under 3 lb. pressure before the change, and now it is never over 3 lb. and the regular pressure is 1½ lb. Before this change was made, water would stand in the hold at the lower end of the line and of course this would get hot and give off vapor which did considerable damage to the building that happened to be over it, which was the dining hall; this has been entirely stopped.

There was a hot well in the boiler room at which the boiler feed pumps would habitually balk and race and fail to lift the water, which was perfectly right and proper for all good boiler feed pumps to do since they are not built satisfactorily to lift water above 140 deg. F.

and these pumps were true to their tribe. I closed up this well and built a concrete reservoir above it on the same ground and had the pump intake pipes put in on a level with the bottom of this reservoir. There has been no trouble with these pumps since. It does not matter how hot the water is now, as long as it is water the pumps will put it in the boilers; in fact, the hotter the better for the boilers. The vacuum pumps are connected so that when one is out of commission the other one is in and all of the water passes from the vacuum pumps through the heater and purifier to the reservoir, through the boiler feed pumps to the boilers; thus we get heat from the steam, and the return water is pumped into the boilers while very hot and is rid of its precipitates, having lately been steam. Most of this work was done by the students of the engineering classes.

ROBERT L. CAMPBELL.

Pump versus Trap Feed

W. L. N.'s letter on page 295 of the March 1 issue calls for comment because the unfavorable conditions he refers to in regard to pump service do not always exist. On the other hand, some of the advantages that he claims for the trap feed cannot always be attained.

He says that the fuel saved will be about 1 per cent for every 10 deg. increase of present temperature of water fed to the boilers. If cold water is taken from

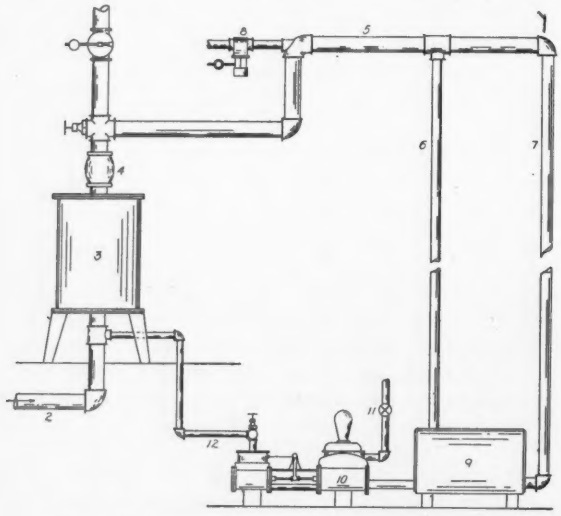


FIG. 1. SYSTEM SHOWING PUMP RETURN

street mains and pumped direct into a boiler, it will require a certain weight of fuel to produce a given power. If an exhaust steam heater is installed and the water is heated by steam that would otherwise be a waste product, we may expect a saving of 1 per cent for each 10 deg. increase, but that does not apply to a modern heating system.

Some time ago I found a plant in which the exhaust steam from two engines and three pumps was discharged through the roof, and live steam was used to heat the shop. After I had remodeled this plant, it showed a substantial saving in fuel, but a return trap was not installed to accomplish this desirable end.

The condensate from a heating system may come back at 210 deg. It costs no more to send this into the boiler with a pump than with a return trap. The latter may discharge at a higher temperature, but if it does, the extra heat is obtained by taking live steam from the top of the boiler and forcing it in at the bottom.

W. L. N. claims that a steady water level is maintained, and a more even steam pressure is carried. Either a pump or a trap will deliver to the boiler the condensate that returns, no more and no less, provided no "make-up" water is added. If it is, the effect will be exactly the same in either case. As far as the even steam pressure is concerned, that will depend on the ability of the fireman.

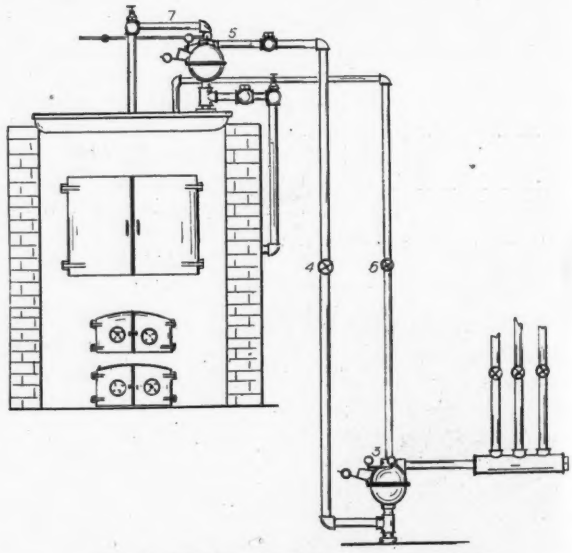


FIG. 2. SYSTEM SHOWING TRAP RETURN

Concerning the claim that feeding with a trap avoids so much strain on the boilers, I would say that the heating system illustrated has been under my direct supervision for 27 yr. and during this time not a dollar has been spent for repairing the boilers. If pumping in water does cause so much extra strain, about when may I expect the bad effects to become apparent?

He says that with a trap the condensed steam loses none of its heat by being exposed to the air, and allowing it to escape in vapor. That is correct, but why are not the same conditions found in a pumping system? If they are not, it is not the fault of the system.

As far as the comparative simplicity of the two systems is concerned, the following illustrations will present that feature so that readers may judge for themselves.

In Fig. 1, exhaust steam from a 110-hp. engine is exhausted into 2 and thence to the heater, 3, and the separator 4, passing to the heating system, 5. The outlets from this are represented by 6 and 7. If there is not enough exhaust steam to supply the system, live steam is admitted by the reducing valve 8 to meet the deficiency.

The condensate falls by gravity to the receiver, 9, and without being liberated or exposed to the air in any way, it is taken by the pump, 10, and returned to the boilers through the discharge pipe, 11. Frequently

the temperature is 214 deg. The pipe for supplying steam to operate the pump is not shown, but the exhaust pipe, 12, discharges directly into the heating system, consequently there is no loss. This pump may require 8 per cent of the steam generated, to drive it; but if it does, this steam is not lost. If it was not so delivered, then the same amount would be supplied through 8. This pump is located about 15 ft. below the proper location for a return trap, but it works perfectly at all times.

Figure 2 illustrates a trap installation to do the same work. Steam could be supplied to the heating system as above mentioned. The condensate would then come back through the three pipes shown, to the header, 2, and as this is in a basement, it would be necessary to install the trap, 3, to send this water up through 4 to the return trap, 5. The steam pipe, 6, is required to operate 3, as there is never pressure enough in the system to force it up. Another steam pipe, 7, must be installed to operate 5, hence if the water is quite hot when it is

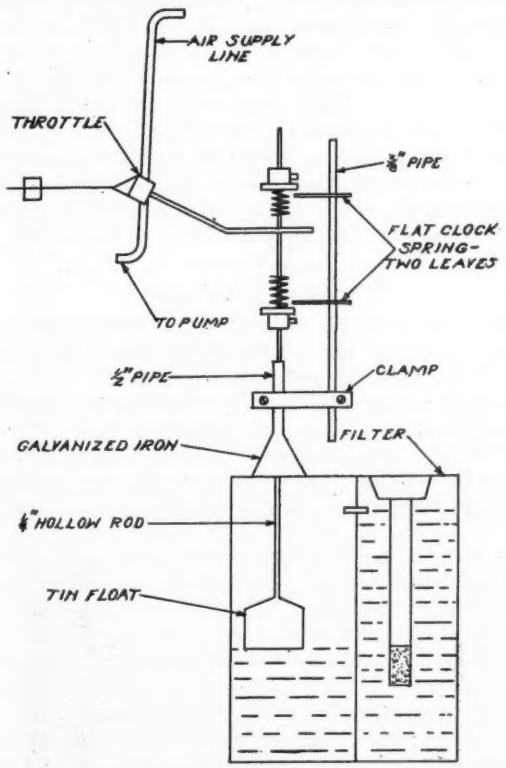


FIG. 1. DEVICE FOR STARTING AND STOPPING OIL PUMP AUTOMATICALLY

discharged into the boiler, it is evident that the heat for this purpose comes directly from live steam.

As to cost of repairs, etc., I would say that this pump has never given the slightest trouble except when a nut on one of the steam piston rods was loosened. The cylinder head was taken off and the nut screwed up. After 18 yr. service, a small job of repairing was required. Since then it has operated for 9 yr. and is still in fair condition. It has required packing twice each year. It is located in a basement room and is inspected twice a day.

W. H. WAKEMAN.

Automatic Pump Starter; Wedge Liners

ACCOMPANYING are two sketches that might be handy for some engineers to apply in their engine rooms.

Any plant having a gravity oiling system in which the oil has to be pumped into a receiving tank near the ceiling can easily install this system or scheme. It eliminates running the pump all the time, also running it at intervals by opening the pump throttle by hand.

I use for a throttle valve a ⅜-in. air plug cock and on the square end I soldered a throttle lever made of ⅛-in. sheet steel; the opposite end of this lever is made forked in order to enable the ¼-in. hollow rod to come in the center. On the hollow rod there are two brass collars with set screws, enabling adjustments to suit the amount of oil that is needed each time the oil is pumped up.

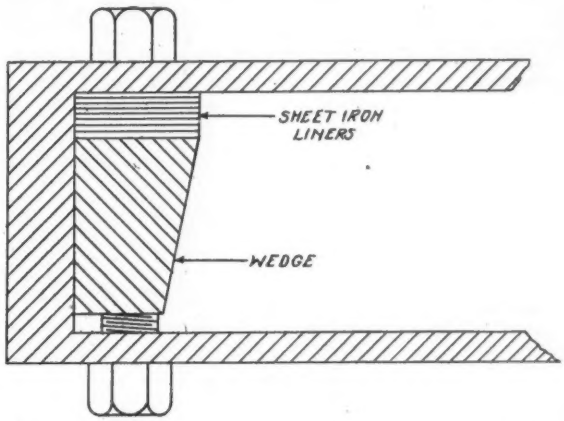


FIG. 2. WEDGE LINERS HOLD BRASSES WITH ONE BOLT BROKEN

The flat clock springs hold the float rod in suspension when pumping out and as the oil lowers, the weight of rod and float will finally pull down on the spring until it trips, then the float will go with a plunge and assisted with the small spiral springs on brass collars will shut off the air and stop the pump.

The same thing is accomplished as the float rises. To adjust, have the spiral spring come in contact with the throttle just as it trips and it will send the lever either up or down. Use a counterbalance on the throttle valve.

If you cannot get a clock spring, use hack saw blades about 5-in. long from support. Solder the blades in the ⅜-in. pipe after you saw the grooves for them.

The other drawing shows liners placed on top of the large end of the adjusting wedge of the connecting rods. Fill in this space with sheet iron liners so that if one of the wedge bolts breaks, you do not have to shut down. Drill a hole in the liners ⅛ in. larger than the wedge bolt. When you have taken up enough or drawn the wedge down and the liners are loose, insert another by taking bolt out. If the bottom bolt breaks, the thrust will push the wedge against the liners and the engineer will be none the wiser unless he happens to see it drop out. If the top bolt breaks, the liners will remain in place if properly applied. I ran an engine one week with bolt broken; I couldn't shut down without interrupting the service.

OAKS KYGER.

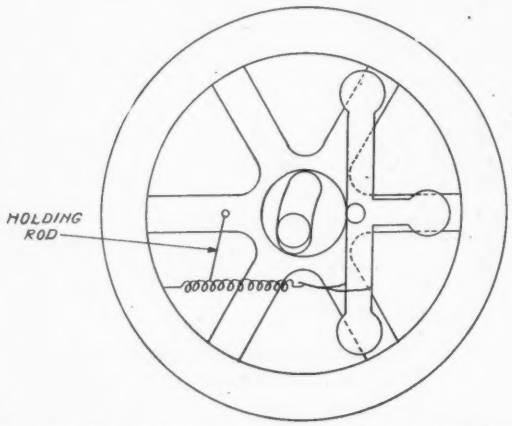
Engine Runaway Narrowly Averted

RECENTLY a very serious accident was avoided in a large Chicago office building when an oiler closed the throttle on a 350-kw. direct-connected unit. I was in the boiler room and had just started for the engine room when the lights brightened up more than usual.

I got to the engine room in 5 or 6 sec. and found the oiler spinning the throttle valve wheel as fast as he could. The voltmeter pointer was in the corner, 300 v., and every lamp was like an arc light. When the throttle was finally closed, I watched the voltmeter and it seemed like 7 or 8 sec. before the hand came back out of the corner. I then walked around the end of the cylinder and opened the throttle about 2½ turns.

Until the load could be transferred and this unit shut down, regulation was maintained by hand.

The cause of the engine acting as it did was a puzzle, as there had been no trouble of a like character previous to this.



FLYWHEEL GOVERNOR SHOWING LOCATION OF BROKEN ROD

From the cut, you will notice a ½-in. rod connecting the spring with one of the spokes of the wheel. This is called the holding rod. The holding rod was found broken, a new one was made and attached and the unit put in service again an hour after being shut down.

Later, to determine what relation this rod had to the operation of the governor, we decided to run the engine with and without the rod in place. Accordingly, on a Sunday we started the engine and let it run on the governor. The voltage was built up to 200 and without touching the rheostat we shut down and removed the ½-in. holding rod.

The throttle was then opened just a trifle at a time until the voltmeter showed 220 v.; but the speed was so great that we thought we were too close to the danger point and shut down, as it was apparent that the governor was not going to act.

The holding rod was attached again and the throttle slowly opened as before. The governor took hold and when it did, the voltmeter showed 50 v. From this point, it slowly continued up until it reached 200 v., possibly about 50 or 60 sec. after cutoff commenced.

When the holding rod broke, the spring bowed, due to centrifugal force, thereby increasing the tension.

This is about a nine-ton wheel, running 150 r.p.m. The spring is of ⅝-in. stock, about 3¾-in. diameter (outside) and 35 in. long. JAY SEE.

Then and Now

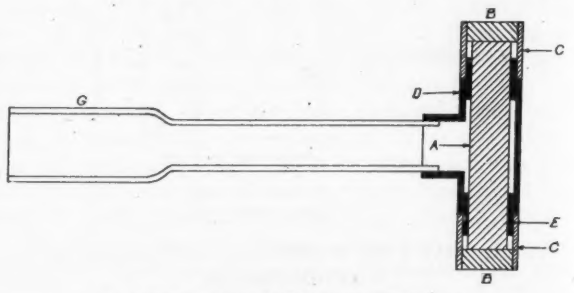
A FEW YEARS ago, a young man starting to work in an office or factory found the going rather difficult when he tried to get any assistance from his fellow employes. There seemed to be a feeling of: "Why should I give to another that for which I had to struggle?"

All that has changed now, and do you know what brought it about? The vocational schools as conducted by the large corporations are entitled to first honor. How? Employes who either refused to impart any information, or dodged the issue, soon found out that pamphlets were being given to all prospective employes that teachers were employed to assist all concerned in learning the wholesome information these pamphlets contained, and that it was only a matter of a short time until the new employe would gather the needed information from the source mentioned, that it would be common property now, hence it is that the clams opened up and in many cases, by their changed attitude, they removed their own "light from under the bushel" and were advanced accordingly. The establishment of these schools by the various corporations, while costing much money to the promoters and none to the students, soon pay for themselves, due to the better class of employes and the co-operative spirit created. J. B. DILLON.

A Heavy Hammer

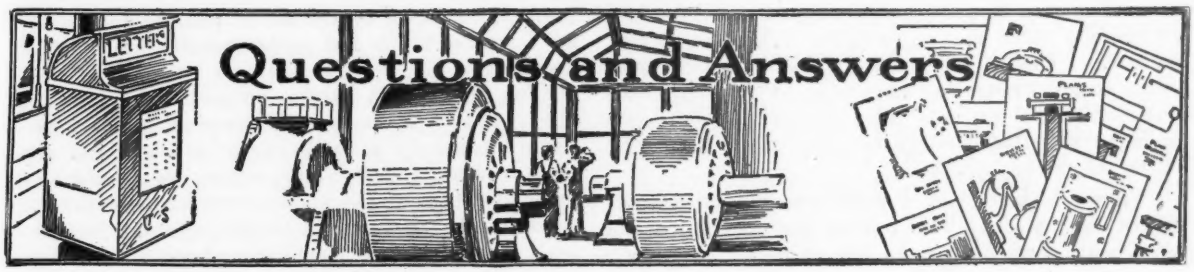
IRON PIPE HAMMERS have been made and used, but the one shown in the accompanying sketch is a new idea, in my opinion, and beats them all.

Material required is one tee, two running nipples, two couplings, two plugs, one piece iron rod and one piece of pipe for the handle. It is not nearly so complicated as it looks, and can be made in a few minutes. For tools of this kind, it is best to use extra heavy pipe.



HAMMER MADE FROM PIPE FITTINGS

The nipples, E, are screwed into the ends of the tee, D, and the couplings, C, turned onto the other ends of the nipples until the faces of the couplings come up against the ends of the tees. A plug, B, is screwed up tight into one end of a coupling and sawed off flush as shown. A piece of rod, A, is cut and placed inside the tee as shown, then the other plug is screwed into place and sawed off flush. The handle is a piece of pipe flattened at the end, G, for a hand hold. It is obvious that any size hammer can be used, but one made from ¾-in. pipe is O. K. JAMES E. NOBLE.



Leaking Girth Seams; Lax Inspection

REPLYING to G. B., page 243, Feb. 15 issue, cracks at the girth seam as they appear from the edge of the plate to the rivet holes are not exactly fire cracks, but cracks in the plate, caused partly in the rolling process of making the plate and the crushing effect in riveting. When exposed to the fire, they open enough to be plainly seen, but are not dangerous as long as they do not extend farther into the plate, that is, beyond the rivet holes, and do not leak; but he states that they leak and new rivets and calking do not stop them. Now, I would first consider the age of the boiler, the thickness of the shellplate as well as its general condition, the service the boiler has been given, the pressure carried and to be carried in the future and how long it could be used after being repaired. Is it worth it? That is the all-important question. If it is in good condition otherwise and not an old boiler, it would be well worth the expense of patching, which the insurance company would permit.

Cracks occur in old boilers from the plate becoming crystallized and such cracks will keep on cracking through the sheet, which makes a crack in a crystallized plate a dangerous affair. When a girth seam leaks badly, it may be caused from two conditions. The presence of oil in the boiler will often start a girth seam to leaking; but when the oil has been removed and the seam and rivet calked tight again, it seldom gives more trouble until more oil gets into the boiler, or other causes enter such as an accumulation of scale to prevent the water absorbing all the heat imparted to the shell from a forced fire. This would allow the plate to be burned and the seam to leak and often it would be bagged. If this is the case, whether cracks have appeared or not, it is a menace to life and property because a burned boiler plate is sure to crack the next time overheated, should the same condition occur again.

When a girth seam starts to leak, it is first necessary to find the cause if possible, and remove it. Then, if the seam is not bagged or badly cracked, have it calked, also the rivets. If the plate is not badly burned, this will stop the leaking; but when a plate is burned badly, no amount of calking or new rivets will keep it tight and cracks are sure to extend farther into the plate sooner or later; the strength has been taken out of the metal and there is no elasticity left in it to expand and contract alike with the new rivets, hence it continues to leak. Have a good boilermaker cut out the burned part (he can tell it by sight from its color) and fit a patch, preferably on the inside, to prevent forming a pocket to catch more scale and cause the patch to be burned. This patch should be oval in shape to prevent as far as possible any rivets sustaining a great amount of the stresses which would come on the longitudinal seam. Such a patch should be riveted on and this will allow the boiler to be used many more years if its age has not already shown signs of crystallization of the plate.

A good hammer tap beside a crack in a crystallized plate will sometimes cause the crack to run farther and farther with each blow; I have seen this done. I have had several leaking boilers calked on the girth seam which gave no more trouble after the cause was removed. One case was oil of a nature which was hard to detect, as it settled to the bottom and on the tubes without affecting the tube ends, but adhered to the plate and girth seam in a greasy mud or scale. I shut

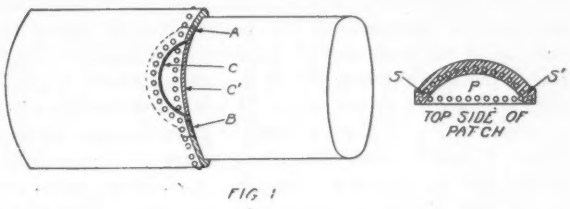


FIG. 1

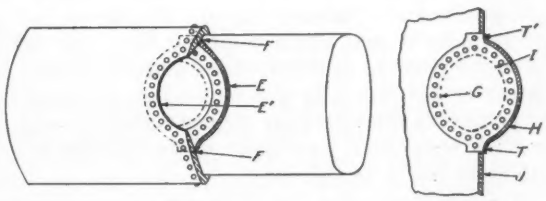


FIG. 2 FIG. 3

FIG. 1. APPLICATION OF INSIDE GIRTH SEAM PATCH
FIG. 2. OVAL GIRTH SEAM PATCH, HALF INSIDE AND HALF OUTSIDE
FIG. 3. SHOWING PORTION OF PATCH UNDER FIRST SHEET

the boiler down and after it had cooled and the pressure was off, I took out the manhole plate and left it out, put five pails of sal soda, mixed in hot water, into the boiler and boiled it with the manhole plate out for about 2 hr., then let it stand over night and emptied and washed the boiler. From that time on, the oil separator on the exhaust main was inspected often and cleaned, also sal soda was fed into the boiler in small quantities at regular intervals with the feed water.

When scale forming impurities in the feed water are the cause, they can be neutralized by using a suitable solvent to soften them and washing the boiler frequently. This will remove the mud and scale forming substances.

Some kinds of oil have a more injurious effect on boiler plates than others, as they mingle with the water collecting with impurities, become heavier and settle on the plates, while other oils float or turn the water a whitish color and can be blown out by the use of some

form of surface blowoff pipe placed just below the lowest running water level of the boiler. Then, by opening the surface blowoff valve and allowing it to blow until steam comes through, all impurities on the top of the water will be blown out. This surface blowoff pipe is an important attachment where boilers are bothered with oil or subject to foaming.

Figure 1 shows how a patch was put on a boiler where the plate had been burned just in front of the girth seam, forming a small bag or pocket, which was cut out to the edge of the plate, also the rivets of the girth seam. The second sheet not being burned, was still in good condition, and the edge of the patch was riveted on as the girth seam. P shows the patch. Before being curved to fit the shell of the boiler, S and S′ show how the corners were scarfed off to fit under the front sheet as at a and b, Fig. 1. C and C′ show the calking edges. The plate was ⅜ in. shell and patch and ⅞-in. rivets were used; pressure carried 115 lb. gage.

In Fig. 3 is shown an oval patch which was put on a boiler as in Fig. 2. In Fig. 3, T and T′ show how the ends were scarfed off to allow two rivets to come in the lap of the girth seam. Sometimes the scarf is long enough to include three rivets where the rivets are small and the pitch short. J shows the edge of the plate and the portion enclosed by the dotted line G shows the amount of plate cut out of the first sheet and the dotted line I the amount cut out of the second sheet; h shows the calking edge of the patch. Figure 2 shows the patch in position, F and F show how the scarfed edges lap each other; E and E′ show the calking edges of the patch and sheet; 110 lb. running pressure. A 7/16-in. plate and patch and 15/16-in. rivets may be used. This patch could also be made diamond shaped. But it was just as easy to make it oval when preparing the patch itself. The size of patch to be put inside of a boiler depends on whether or not it can be put in through the manhole. But patches as illustrated are slipped under the edge of the boiler sheet from the outside where the edge of the girth seam has to be cut out.

Where a large patch has to be put on the sheet between girth seams and the patch is too large to go through the manhole, it must be put on on the outside and riveted and the patch calked all the way around on the edge to make it steam and water tight. In one case half of the first sheet was cut out and a new sheet put on from the girth seam to the front end of the boiler, making it necessary to put two longitudinal seams on the front section sheet of the boiler. This plate riveted to the flange of the head and the girth seam making a good job, which saved the price of a new boiler. This brought the longitudinal seams above the fire line of the boiler. This was necessary because the length of the patch was such that the rivets on the edges would come on a parallel line with the longitudinal seam and therefore be subjected to the same stress, and double riveted lap joint could not be used and by putting on a half sheet section a triple riveted butt strap joint could be used on the edges, above the fire line, which made the boiler as good as new.

When girth seams become burned the rivets are also burned and stretch and become set. In this stretched position they will not contract equally with the plate when cool, expand even more when heated up again and are liable to break as well as the plate to crack. They are a menace to life and property while the boiler is in operation.

The reason most patches on return tubular boilers are made oval or diamond shaped is to avoid double or triple riveting on a patch where the patch and rivets come in contact with the fire which, on account of the extra thickness of the plate and rivets, will cause the heads of the rivets to be burned, also the patches or plate. The oval or diamond shaped patch prevents any two rivets on the edge of the patch coming into the same parallel with the longitudinal seam, hence it does not sustain the same stress as the longitudinal seam though the rivets of the patch must sustain more strain than those of the curvilinear or girth seam, but not enough to be dangerous. R. A. Cultra.

Pointers on Gas Engine Operation

In answer to the request of "L. E. H.," March 1 issue, page 294, I submit the following account of my experience with gas engines which extended from Sept. 1, 1915, to Nov. 10, 1917. On the latter date my plant was destroyed by fire.

I had been operating a 75-hp. Frost steam engine, pulling a 30-kw. 133-cycle alternator, with good satisfaction. The engine, however, needed overhauling and as I was anxious to increase the efficiency of my plant, I finally contracted for a Munzel, suction, gas producer outfit of 65-hp. rating. The engine had a 17 15/16 by 24-in. horizontal cylinder and was fitted with a 5¼-ton flywheel. I had never operated such an engine before, and had seen only one in operation. The work of installing and planning was all done by myself, working from plans furnished by the manufacturer.

On Aug. 28 the engine was put into operation, my patrons never noticing any difference. From that date on I lost only one night's lights, owing to an over-tight crankpin bearing, and on several occasions I was late getting good gas to operate on.

I had to grind in my exhaust-valve on an average of once a week; later on, when I ordered a new exhaust valve, my troubles began, as I lost fuel by a leaky valve losing compression.

All data was conscientiously kept, ammeter readings were taken every 15 min. during runs (which were from dark to 11 p.m.). Every piece of screening (pea-size anthracite) used was weighed and recorded. In this way I was able to see at a moment's glance just what I was doing.

My engine was guaranteed to operate within 2 per cent of speed, and I fully believe she kept well within this limit. Lights were good.

I soon found out that "eternal vigilance is the price of watchfulness," especially when it comes to four-cycle gas engines.

With the new exhaust-valve it was an every-other-day job, grinding this valve, and even then I had only indifferent success.

As to lubrication, I soon hung a 15-gal. tank above the engine, and played a small stream of oil constantly on the crankpin, which did very well indeed; also, I never skimped on cylinder oil. The engine oil I refil-

tered, in this way using only about 15 gal. of oil a year, cheap enough, I think.

I was advised to carry cooling water pretty hot, but never experimented much along that line; mine was generally rather cool; it was pumped to the roof-tank and used over and over again. This was another point of economy since we bought water.

As to cost of operation: Since one month was much as another, an expert took two months and figured that I was generating a kilowatt-hour at 0.016, as cost for fuel, and with engine averaging less than one-half load, while a full load would have made a much better showing. I never had a chance to try this.

There was some fun operating this machine, for on one occasion at least, there were visitors in the plant when she pre-ignited; they took to their heels and never came back.

Together with "L. E. H." I've often wondered just why not more is heard about the producer-gas-engine. Had I to do it again, I believe I would try to get away from the exhaust valve, the only bugbear I found about the engine. A mighty hot exhaust could be put to good use for heating purposes, where conveniently located. I could not use it. FRITZ BEERBAUER.

Material for Blowoff Pipes

IN ANSWER to the question on page 294, March 1 issue, asking, "What Should He Use for Blowoff Pipe and Fittings?" I would say that at one time I was bothered the same way with blowoff pipes, and used a blowoff pipe covering cement. I believe I stayed 2 yr. in that plant and I never was bothered again except when the boiler inspector came; then I had it taken off and all that was needed was a can of cement. That is the best that I ever used; it was 2-in. pipe, made of brass, which is the best material for blowoff or feed pipes, if you can keep it away from the fire. H. ARMSTRONG.

IN ANSWER to W. S. H., extra heavy iron pipe is a universal standard for the purpose mentioned and should give perfect satisfactory service. If, however, the master mechanic cares to go to a little more expense and enlarge the feed pipe to 2 in., make up all the connections to exact lengths, screw couplings on the threaded ends to protect them, send them to a pipe enameling works and have them glass coated outside and in. Make up with extra heavy cast-iron fittings and you will have a job that is noncorrosive. An asbestos covering on the pipes he mentions would promote corrosion should they become damp and it is doubtful whether such covering would promote the life of the pipe. CHARLES B. RISLEY.

IT SEEMS to me that if this feed pipe were wound around with ball asbestos once a year to keep the heat away from it, the corrosion would cease, as it is a well known fact that brass pipes in places of excess heat, such as blowoffs on horizontal return tubular boilers, do not last long and are not usually allowed by insurance companies. His idea of having extra heavy iron pipe for his feed line is all right for a time, to withstand the heat, but he will probably be bothered with corrosion. The use of iron for blowoff connections is recommended because corrosion here is a minor factor since there is seldom water in the pipe.

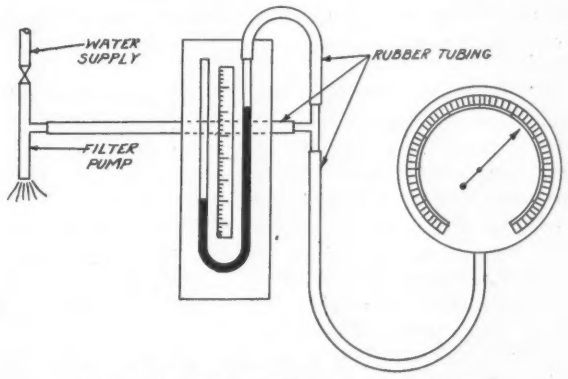
I have several extra heavy blowoff pipes, uncovered but protected with brick piers, that have been in service for over 14 yr. Feeling that they were in need of an inspection, I took one out, but it was in such good condition that I did not touch the others.

A. WALDRON.

Testing a Vacuum Gage

HAVING SEEN an inquiry in the Mar. 1 issue as to the method to use in checking a vacuum gage, I am sending this in thinking that it might be of interest to someone.

There are several simple methods for testing vacuum gages, all of which necessitate the use of a mercury or water column or U tube. The one recommended by instrument makers entails the use of a hand operated vacuum pump with two connections, one for the gage to



APPARATUS USED IN TESTING A VACUUM GAGE

be tested and another for a mercury column. As the pump handle is worked back and forth and the air exhausted, the vacuum rises higher and higher and the gage may be checked at different ranges by comparison with the mercury column. This method, while very good, is rather expensive as a pump and mercury column of this description cost approximately $100.

A simple and efficient method of testing vacuum gages may be obtained by the use of what is known as a filter pump. This is a small contrivance designed to be connected to an ordinary water faucet. It operates on the principle of an injector; i. e., the water flowing through a restricted area creates a vacuum in an outlet connected at that point and thus by simply turning on the water, we have a source of vacuum. A length of glass tubing (about 6 ft.) should be bent in the form of a U with the vertical legs about 1 to 2 in. apart. This tube should be half filled with mercury and connected to one end of a glass T with rubber tubing. (If this is not available, take a ⅛-in. pipe T and screw a short nipple in each outlet.) From the other outlets lead lengths of rubber tubing to the filter pump and gage to be tested.

When the water is turned on, the distance between the mercury levels in the two legs may be measured and the gage checked with these readings. A vacuum of 29 in. has been obtained by the writer with an apparatus of this kind.

If the gage in question is already connected to a source of vacuum and it is only necessary to check it at one point on the scale, this may be done by connecting the above mentioned glass U tube to the same source of vacuum and setting the spring gage to correspond with the difference in levels in the two legs.

J. T. W.

Massachusetts Examination Questions

On page 339 of March 15 issue, J. A. H. has some questions that he would like to have answered.

If I were inspecting a boiler and found a stamp, "Indian Head Cast Steel 60,000 T. S.," I should consider that it had been through the pouring of the crucibles without the addition of manganese carbonate, which corrects the brittleness of cast steel. Cast steel is obtained by melting pieces of blister steel in covered crucibles of plumbago and fire clay. The crucibles are arranged in sixes or twelves in a reverberatory furnace. Several crucibles are poured at once to secure a uniformity. This steel is more homogeneous than "shear steel" and possesses greater tenacity, with a finer structure.

C. H. M. No. 1 Flange would mean to me that this was charcoal hammered iron, with manganese. This iron is made from only the best scrap iron with charcoal hammered blooms with manganese added. It is the least fibrous, and the best of irons. It is less liable to blister and crack on account of its nearer approach to a homogeneous structure. This is the highest grade of iron regularly offered in the market, and was used in construction of marine boilers, and for heads and other flange plates of land boilers.

The Dean boiler is a straight upright boiler, the tubes of which are about 13 ft. long. They are about 12 in. from the shell, thus leaving a space around them for an internal inspection. The boiler is entered through a manhole on the side and a ladder hung from a track overhead can be pushed around inside when inspecting. The space overhead where there are no tubes is braced to the shell by angle braces. Handholes for cleaning crown or lower tube sheet are not needed, but they are needed over the fire door and at the bottom of the water leg. The inside firebox sheet is smaller at the top than at the bottom to allow for free circulation of water from and into the water leg. This construction makes a longer stay bolt necessary at the top of the water leg.

W. N. L.

Miscellaneous Electrical Questions

What are the carrying capacities of Nos. 14, 12, 10, 8 and 6 wire in amperes in concealed work?

A. The allowable carrying capacities of these wires, used in concealed work, are 12, 17, 24, 33 and 46 amp. respectively.

2. What is the proper spacing of circuit wire in knob and tube work?

A. Within partitions and floors where the wires are carried on knobs, the knobs should be spaced at least 4½ ft. and the wires at least 5½ in. and should be carried on separate timbers.

3. Under what conditions may wire mold be installed?

4. Can it be run through partitions?

A. Wire used in molding must have a standard rubber insulating covering and must be in continuous lengths from outlet to outlet or from fitting to fitting, no joints or taps to be made in the molding.

It must never be placed in metal molding in damp locations; must never be placed in metal molding in concealed locations or where the difference of potential between any two wires in the same system is over 300 v.

Permission may be obtained from local authorities to extend moldings through walls and partitions if the molding and capping are of continuous lengths where passing through the walls and partitions. Not more than four No. 14 B. & S. gage rubber covered wires, and no single circuit of more than 1320 w. shall be used in metal molding.

For alternating-current systems, if in metal molding, the two or more wires of a circuit must be installed in the same molding.

5. What materials would be used on a 25-hp. installation? Give size of wire and conduit—also size of ground wire and grounding necessary.

A. For such an installation there would be required the necessary control switch, circuit breaker and starting box or compensator. For mains in the case of a 110-v. system, a 0000 conductor would be required while on a 220-v. system, No. 1 wire would do. For three-phase work, main-line conductor for 220 v. would use a No. 4 and on a 440-v. circuit a No. 6.

For two 0000 conductors use a 2-in. conduit; for two No. 1 wires a 1½-in. conduit; for three No. 4 wires a 1¼-in. pipe and for three No. 6 lines a 1-in. pipe.

6. How should a single-throw knife switch be installed?

A. A single-throw knife switch should be installed so that when in the "up" position the switch is closed.

7. What is the smallest size wire which can be used in grounding?

A. Conduit ground wires must be of copper, at least No. 10 B. & S. gage (where largest wire contained in conduit is not greater than No. 0 B. & S. gage) and must be at least No. 4 B. & S. gage (where largest wire contained in conduit is greater than No. 0 B. & S. gage).

8. How can you determine the size ground wire to be used on different installations?

A. This is specified by the National Electrical Code.

9. What is the smallest size wire which may be used in fixtures?

A. Fixture wires must not be smaller than No. 18.

10. What is the smallest size wire which may be used in wiring a building?

A. As a rule, No. 14 is the smallest size wire allowed in interior work.

11. What are the necessary requirements when fixtures are installed outside?

A. The prime requirement of an outdoor fixture (other than those of indoor fixtures) is that it be absolutely weatherproof.

12. What materials should be used in making up fixtures, using gas-filled lamps of over 100 w., to take care of the heat?

A. In wiring fixtures to be used with gas-filled lamp of 100-w. rating and from which considerable heat

emanates, standard slow-burning wire should be employed.

13. What is the voltage of four storage batteries, each containing three cells of 2 v. each, when connected in multiple?

A. If the four batteries are connected in multiple, the voltage of the group will be the same as that of any single battery. Each battery is made up of three cells (connected in series, we presume) of 2 v. each so that the terminal voltage of a battery is equal to 6 v.

14. When is it permissible to carry more than 660 w. on a No. 14 circuit?

A. By special permission, in cases where wiring equal in size and insulation to No. 14, B. & S. gage standard rubber covered wire is carried direct into keyless sockets or receptacles such as to render unlikely the attachment of flexible cords thereto, the circuits may be so arranged that not more than 1320 w. will be dependent upon the final cut-out.

15. What is the amperage of a battery of seven dry cells, each cell testing 20 amp. when connected in series?

A. With the cells connected in series, the amperage of the battery will be the same as that of the individual cells, or 20 amp.

Boiler Problems

WHAT IS the evaporation, efficiency and horsepower of a boiler from the following data: Boiler steam pressure 90-lb. gage, feed water temperature 212 deg. F., total water evaporated per hour 20,344 lb., total coal burned per hour 3250 lb., B.t.u. value of coal 12,000?

2. What boiler horsepower is necessary to furnish steam for the following engine: 20 hp. noncondensing to use 50 lb. of steam per horsepower-hour; boiler steam pressure, 80-lb. gage; feed water temperature, 120 deg. F.?

3. What boiler horsepower is necessary to furnish steam for a 15,000-kw. steam turbine and auxiliaries, which require 14.7 lb. of steam per kw.-hr. at rated load; superheat, 150 deg. F., feed water temperature, 179 deg. F. J. S. S.

A. The actual evaporation is 20,344 ÷ 3250 = 6.27 lb.

The factor of evaporation equals $(xr + q - q_2) \div 970.4 = (0.97 \times 885.2 + 302 - 212 + 32) \div 970.4 = 1.00$.

Where "x" is the quality of the steam, which we will assume as being 97 per cent, "r" is the latent heat of evaporation, "q" is the heat of the liquid, "q_2" the heat of the feed water above 32 deg. The evaporation from and at 212 deg. will then be $6.27 \times 1 = 6.27$ lb.

The efficiency is then equal to $(6.27 \times 970.4) \div 12{,}000 = 50.75$ per cent.

The horsepower developed is $(20.344 \times 1) \div 34.5 = 590$.

2. A 20-hp. engine using 50 lb. of steam per horsepower-hour uses 20×50, or 1000 lb. of steam per hour, actual. The equivalent quantity of steam from and at 212 deg., where actual conditions are 80 lb. pres. gage, feed-water temperature 120 deg. $= (1185.7 - 120 + 32) \div 970.4 \times 1000 = 1130$ lb. per hr. The horsepower is then $1130 \div 34.5 = 32.8$.

3. A 15,000-kw. turbine using 14.7 lb. of steam per kw.-hr. at rated load will use 220,500 lb. of steam per hour actual. The equivalent rate, from and at 212 deg. with 200 lb. pres. gage, 150 deg. superheat, and feed water 179 deg. $= (1284.6 - 179 + 32) \div 970.4 \times 220{,}500 = 258{,}500$ lb. The boiler horsepower necessary is then $258{,}500 \div 34.5 = 7500$ hp.

Boiler Primes

IN THE PLANT where I am employed we have three vertical water tube boilers rated at 250 hp. each, containing 252 3¼-in. tubes with superheaters, stokers and one economizer containing 284 4-in. tubes. The single acting feed pump gets its supply from a supply tank 12 ft. above the pump, suction 3 in., discharge 3 in., size of pump 10 by 6 by 12 in. It discharges first through a closed feed-water heater thence through the economizer to the boilers. The feed heater is on the same level as the pump. The economizer is 50 ft. above the pump. The steam main is 12 in. in diameter leading to engines and generators, also for heating and cooking purposes, and carries 90 lb. pressure. The water from feed heater to economizer is 175—190 deg. F., from economizer to boiler 225—250 deg.

On two occasions the boiler has primed and carried the water from the boiler with two gages full of water so that you could not see any in the glass, and on one occasion had to pull the fire and shut down the boiler. The boilers are clean and washed down every month and blown down a cock three times a day. I use graphite and soda as a compound, fed through a feed regulator, alternating a pint of graphite and a half pail of soda. It never occurred in starting up a boiler until a week after being in service. Can this be caused by the pump stopping and the economizer getting steam bound? If not what could cause it? The steam main connection runs horizontally across the top of the boilers branched off to the engines, and it makes a loop of 4 ft. This trouble has never occurred when two boilers were in service. H. H.

Feed Water Heater Correction Note

IN OUR Jan. 15 issue on page 143, there is an article on Feed-Water Heaters, Fig. 1 of which is in error as called to our attention by the author. This illustration shows two steam traps, one taking condensate from the heating system and delivering it to an automatic receiving tank, and the other, on the same level, taking water from this tank and delivering it through a heater to the boiler. This arrangement is obviously impossible. The heating system should drain into the receiving tank from which the first trap takes the condensate along with the necessary make-up water and delivers it through the heater to the second trap which should be located above the boiler. The cut was made from a direct tracing of the drawing which accompanied the manuscript and the incorrect arrangement inadvertently escaped our attention.

THE LARGEST power plant equipment exhibit ever held in Chicago will be on display at the Municipal Pier, June 8, 9 and 10, 1921, under the auspices of the Central States Exhibitors' Association in conjunction with the annual convention of the Illinois State Association of the National Association of Stationary Engineers.

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CONTENTS

The New Gulbransen-Dickinson Plant. Illustrated.....401
Stability of Cost of Power. By L. W. Alwyn-Schmidt.....405
Results. By C. R. Tighe.....407
Methods of Recooling Condensing Water—II. By The Terrell Croft Engineering Co. Illustrated.....408
Elevator Inspecting. By Arthur D. Palmer. Illustrated.....412
Small Water Power Developments. Illustrated.....414
Testing Cleanness of Producer Gas. By H. F. Smith.....417
The Weight of a Conical Pile of Ashes. By N. G. Near. Illustrated.....418
Remodeling Switchgears for Power Systems—IV. By Stephen Q. Hayes. Illustrated.....419
Factory Equipment for Industries. By Reginald Trautschold. Illustrated.....423
The Ice Plant of the Ainsworth Pure Ice Co. Illustrated....426
Weighed and Found Wanting. By George H. Wallace. Illustrated.....428
Explosion in High-Pressure Compressed Air Line. By E. D. Gardner.....430
Collapsing Strength of Iron Pipes and Tubes. By W. F. Schaphorst. Illustrated.....431
Letters Direct from the Plant: Solution of an Ash Handling Problem. Lubrication Knowledge. Pump vs. Trap Feed. Automatic Pump Starter; Wedge Liners. Engine Runaway Narrowly Averted. Then and Now. A Heavy Hammer. Illustrated.....432
Questions and Answers: Leaking Girth Seams; Lax Inspection. Pointers on Gas Engine Operation. Material for Blowoff Pipes. Testing a Vacuum Gage. Massachusetts Examination Questions. Miscellaneous Electrical Questions. Boiler Problems. Boiler Primes. Illustrated.....437
Editorial: Induction Motors for Varying Speeds. America, The Greatest Plant in the World. By Frank C. Vogan....442
Self-Respect in Business. By Dr. Frank Crane.....443
Recording Thermometer. Illustrated.....444
New Type Lightning Arrester. Illustrated.....444
High Pressure Damper Regulator.....445
National Research Council.....445
Walter F. Deming. Illustrated.....446
Block Plant Discussed by Chief Engineers.....446
News Notes.....447
Trade News.....447

Induction Motors for Varying Speeds

While the use of the induction motor for driving machinery in industrial plants is becoming increasingly more common, there are nevertheless a number of conditions where the application of this motor is not commercially feasible on account of its inherent speed characteristics.

As regards ruggedness, simplicity both of construction and operation, cheapness, and reliability, the induction motor has no equal and its use is therefore to be desired wherever possible. Practically the only objectionable feature possessed by this motor, disregarding its effect upon the power factor of the system, lies in its lack of flexibility as regards speed. It is substantially a constant speed machine and while there are a number of methods available by which its speed can be controlled, most of them are limited to certain individual conditions or introduce complications, which tend to counteract the inherent simplicity of the motor itself.

The speed of an induction motor is dependent upon the number of poles on the machine and upon the frequency of the circuit from which it is operated. Since the frequency of circuits throughout the country has been fairly well standardized, the standard type of induction motor, when connected to these circuits, will operate at a more or less standard speed. If this speed conforms to the speed requirements of the machine to be driven, all well and good—the induction motor may then be applied without further difficulty. If, however, the normal operating speed of the machine to be driven is either higher or lower than the speed of the induction motor, difficulties arise which must be overcome before the induction motor can be used. Of course, gearing or belting may be resorted to, but such methods are usually expensive and undesirable, hence some other method must be employed.

An interesting case of this kind and the manner in which the difficulty was overcome is mentioned in the article describing the new Gulbransen-Dickinson plant in the pages of this issue. In this plant a number of wood shapers are equipped with induction motors, the rated speed of which, however, is considerably less than the desirable speed of the shapers. As all of these shapers are designed to operate at the same speed, the problem was easily solved by the installation of a frequency changer which furnishes a current of increased frequency to the individual induction motors, resulting in an increase of speed.

This effective solution was applicable because of the uniformity of the speed requirements of the individual machines. Had each of the shapers been required to operate at a different speed, the frequency changer method would not have been commercially applicable. There are many instances, however, where this method of changing the speed of induction motors may be applied, in textile mills for instance, or other places where a large number of motor driven machines operate at the same speed; also in cases where one very large motor is required to operate at a different speed from that obtainable with the frequency of the standard circuit.

The effectiveness of this method increases as the number of individual motors increases. Unless the motor is a very large one, the use of this method would not

be economical with only a single motor—gearing or belting would probably be better in that case.

It is up to the engineer to determine where the system may be economically applied.

Perplexing problems of this nature frequently confront the engineer and his success and reputation are often dependent upon his ability to weigh the advantages and disadvantages of certain comtemplated solutions against each other.

America, the Greatest Plant in the World

Anyone having occasion to make inspection of our industrial plants at this time is, no doubt, shocked at the conditions observed. Very few of the plants in question are without their service stripes. Most of them were operated at 100 per cent capacity during the war. Most concerns, in fact, greatly overtaxed their equipment in the great struggle. The war exacted a terrific toll in men and in machinery. The war was won, the men have slackened their pace, but what can be said of the power plants? Memory requires no straining to recall the many instances in which plants and their machinery were forced far beyond the point of healthy endurance.

During the war period, no let-up for repairs could be sanctioned. Repairs and replacements in all sorts of plants were referred to the day when the war would end. Circumstances are different now. Every suggestion that the plant be put in shape today meet with the excuse that the opportune time has not yet arrived. We modestly ask when this time will arrive. Make no mistake about it, we are today in the midst of very available days for the making of repairs to the tired-out plant.

Reaction has automatically interrupted production, many plants are on short time, and many more are entirely closed. With these conditions obtaining, are we mending our fences? How about the patched boilers, leaky steam lines, decrepit generating equipment and many more items in the same category? They, many of them, are still limping along in about the same inefficient manner as of two years ago.

Just a word to the fellow in the front office. We have all had the vacation that we sought, and like all other things in this life, will sooner or later pay for it. The long looked for opportunity for fixing up the plant is with us. The management must take its eyes off the chart for a few minutes, must stop reading those curtailment reports and apply just good common sense for the while. We have heard a lot about the joy many an ardent worker gets out of good hard work. We want to believe in him. We think he is sincere. Dreams of Pinehurst are all right provided you finish your work at home before you leave. A corking fine time awaits you out in the plant, so come on out and acquire through your giving. Get your salesmen together, give them more positive talk than they have had before, send them forth with a healthy promise to fire the first one of them caught spreading sigh propaganda. Then begin to practice that which you preach. Start something yourself; the other fellow's very effort to stop you will bring him out of his fever.

We have wrought the greatest plant in the world, America; let's keep her going.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

Self-Respect in Business

By Dr. Frank Crane

WHAT the business man needs is self respect. Respect for himself, respect for the business he is in, respect for his labors and his aims, are essential to his contentment and to his enjoyment of what he earns.

There is a good deal of the old humbug about the disgrace of being "in trade" that lingers like virus in our veins. We have inherited it, along with a lot of other lies and nonsense, from generations of monarchy.

All the aristocracies of the Old World are founded on the rotten idea that the man who does not work is superior to the man who does work. You are noble, over there, in proportion to the distance you can go back in your ancestry before you come to a forefather that earned his salt.

All the snobbery in America is an imitation of this sentiment. The young dude loafing in white flannels at Palm Beach while better men up North are shoveling snow and sawing wood, thinks he is a Superior Person.

The young lady who does nothing but study up new ways to spend money that somebody else worked for, gives herself airs over the seamstress who made her petticoats and the cook that prepares her food.

As a matter of fact, the most honorable thing any human being can do in this world is to Serve.

The first thing every boy or girl ought to learn at schools—even before arithmetic and spelling—is to do some kind of work the world is willing to pay money for.

The first and finest streak of nobility in any man or woman is a disposition to do something to make money, and thus get himself or herself off other people's backs.

We talk of "doing good" with our money, after we have made our fortune, by which we mean endowing some institution, when the truth is that the best results of our money come from the way we make it, not the way we spend it.

To conduct an honest business, to give industrious people employment and enable them to live in decency and educate their children, to provide our customers with goods worth their money, and to set an example of integrity and thrift in the community, is as high a calling as any man can have.

This is the Gospel according to America.

This is the creed of decent, square, independent and courageous men. There is no higher rank among intelligent people than that of

Business Man.

Copyright, 1921, by Dr. Frank Crane.

Recording Thermometer

A RECORDING thermometer, especially adapted for measuring and recording temperature of quenching baths, oil tempering baths, and core treating ovens, has recently made its debut into the engineering field.

This instrument is an adaptation of the well known gas thermometer. A gas filled bulb, placed where the temperature is to be measured, communicates with the recorder by a small capillary tube. Change in pressure in the bulb, occasioned by a change in temperature of the fluid whose temperature is to be recorded, is transmitted to a Bourdon tube. The movement of this tube is amplified and transferred to a pen arm which registers temperature on a chart.

Such a thermometer is shown in the accompanying illustration with its bulb and connecting tube.

DISTANCE TYPE RECORDING THERMOMETER SHOWING GAS BULB AND CONNECTING CAPILLARY TUBE

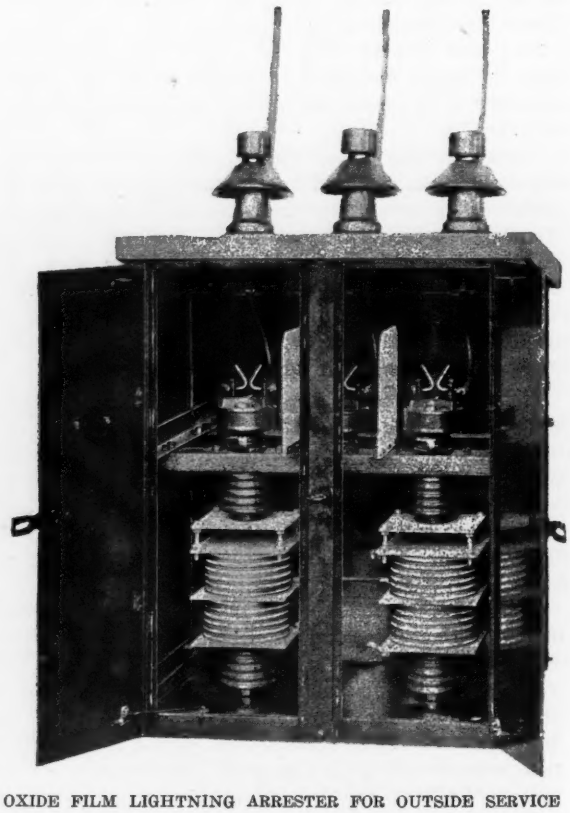
These thermometers are made in three classes. Class 1 instruments have evenly graduated charts and are for use between temperatures of 25 and 150 deg. F. This class is compensated for room temperature but it is not recommended that the chart be located farther than 15 ft. from the bulb. Class 2 instruments have increasing graduations at the higher temperatures. They are suitable for ranges up to 400 deg. F. The bulb pressure may be transmitted as far as 150 ft. but the elevation of the bulb and chart must be approximately the same. Instruments of Class 3 are adapted to temperatures up to 1000 deg. F. Distance transmission, difference of elevation between bulb and chart and ordinary changes in atmospheric condition have a negligible effect on their accuracy.

There are several points of refinement that are worthy of note. The pen arm is completely adjustable with set screws for set and tension. The helix is capable of calibration. The pen is suspended from above so that the inconvenience, resulting from ink running down the arm, is eliminated. The pen is automatically lifted from the chart when the door is opened. The chart is automatically clamped to the dial when the door is closed, thus doing away with the nuisance caused by the chart slipping. A large series of charts ranging from 40 to 1000 deg. F. having both equal and unequal graduations are available for use on these instruments.

Instruments are made for recording two temperatures on the same chart. Where the two temperatures are always different and there is no danger of the record lines crossing, as in hygrometer measurements, a single scale of temperatures may be used, otherwise charts having two different ranges are used.

New Type Film Lightning Arrester

A TYPE of oxide film lightning arrester suitable for outdoor use to furnish protection on lines where the voltages range between 1000 and 7500 v. has recently been developed. It is especially adapted to protecting isolated low-voltage transformer installations of comparatively large capacity, or low-voltage generating plants and substations where lack of attendance or space made the other types of arresters impractical.



OXIDE FILM LIGHTNING ARRESTER FOR OUTSIDE SERVICE

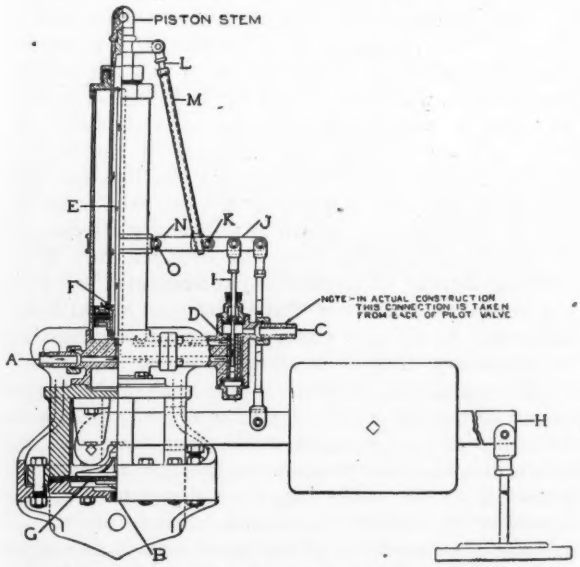
The new oxide film arrester consists of a stack of oxide cells totally enclosed in a steel case. The spark gaps are also enclosed in this case, which allows the same gap settings for outdoors as would be used indoors, which insures high sensitiveness. The arresters are made for platform mountings, the size and weights being such that the installation is a fairly simple matter. They require no attention outside of inspection after lightning storms, and a semi-annual testing to see that they are in good shape.

High Pressure Damper Regulator

A NEW hydraulically operated damper regulator suitable for boiler pressure up to 250 lb. has recently been developed. It is designed automatically to regulate the steam pressure on high-pressure power boilers.

The cross-sectional view herewith of this regulator shows all details. The operating water, under pressure, enters the regulator through the inlet A and as indicated by the arrows passes to the pilot valve, then to the bottom of the control cylinder through port D. It also passes to the control cylinder on top of the piston through pipe E into the hollow piston stem and into the control cylinder through holes F.

Pilot valve stem I is of spool form with the upper head passing over port D, which when above the port permits the water to pass into the bottom of the cylinder, and when below the port permits the water to escape from the bottom of the cylinder into outlet C.



NEW HYDRAULICALLY OPERATED DAMPER REGULATOR

The area of the top of this piston is reduced by an amount equal to the cross-sectional area of the piston stem, whereas the area of the bottom of the piston is larger. We therefore have two opposing forces pushing against opposite sides of the piston, the constant pressure acting against the lesser area on top of the piston tending to force it down and the variable pressure from the pilot valve tending to push it up; therefore, when pressure is admitted to the bottom of the cylinder the piston is forced up, and when the pressure is permitted to escape from the bottom of the cylinder the constant pressure forces it down.

When the steam pressure under diaphragm G is sufficient to raise lever H, the pilot valve stem I is pulled up by lever J, swinging on axis K, this permits the water to pass into the bottom of the control cylinder and force the piston up.

As the piston moves up, rod L is pulled upward in sleeve M, which is rigidly attached to lever N, swinging on axis O. As the point where rod L is attached to the piston stem travels in a straight line, the angle at which sleeve M stands is lengthened and to meet this longer angle sleeve M must swing outward, which depresses axis K on the end of lever N. This pushes pilot valve stem I down, so that the upper head of the stem covers port D, and shuts off the water supply to the bottom of the control cylinder which checks the upward travel of the piston.

When the steam pressure falls, lever H lowers and pulls pilot valve stem I down, so that its upper head is below port D. This permits the water in the bottom of the control cylinder to escape into outlet C, which allows the constant pressure on top of the piston to force the piston down.

As the piston moves down rod L, sliding into sleeve M, shortens the angle at which sleeve M stands and to meet this shortened angle, sleeve M must swing inward, which raises axis K, and pulls pilot valve stem I up so that the upper head of the stem covers port D, and shuts off the water discharge from the bottom of the cylinder, which checks the downward travel of the piston.

The compensating attachment acts as an intermediary medium to counteract the movement transmitted to the pilot valve by the steam pressure under the diaphragm, which balances the position of the damper on intermediate pressure changes, and permits the damper to be fully opened or closed only on extreme boiler pressure variations.

National Research Council

UNDER the auspices of the National Research Council and Engineering Foundation, in the building of the National Research Council, Washington, was effected, March 15, the organization of the Personnel Research Federation. This Federation includes in its membership scientific, engineering, labor, management and educational bodies. The Personnel Research Federation has been organized to bring about interchange of research information among the numerous organizations who are engaged in personnel research. It is reported to the new Federation by the Bureau of Labor Statistics that there are 250 such organizations in the United States. The Personnel Research Federation will collect research information, will encourage research through individuals and organizations and will co-ordinate research activities.

Temporary officers were elected as follows: Chairman, Robert M. Yerkes, representing National Research Council; vice-chairman, Samuel Gompers, representing American Federation of Labor; treasurer, Robert W. Bruere, representing Bureau of Industrial Research; secretary, Alfred D. Flinn, representing Engineering Foundation; acting director, Beardsley Ruml, assistant to the president of Carnegie Corporation of New York.

The aims of the new organization are: Increased efficiency of all the personnel elements of industry—employer, manager, worker—and improved safety, health, comfort and relationships.

The immediate purposes of the Personnel Research Federation will be: To learn what organizations are studying one or more problems relating to personnel and the scope of their endeavors; to determine whether these

endeavors can be harmonized, duplication minimized, neglected phases of the problems considered, and advanced work undertaken.

Nov. 12, 1920, a preliminary conference was held in Washington under the auspices of National Research Council and Engineering Foundation, attended by forty persons, including representatives of national organizations of scientists, engineers, labor, capital, managers, educators, economists and sociologists. The question under discussion was the practicability of bringing about co-operation among the many bodies conducting research relating to men and women in industry and commerce, from management to unskilled labor. Such topics as the relations of persons doing different parts of the work, and the influence of working conditions upon the health, output and happiness of the workers, are examples of those which could be made subjects of research.

Walter F. Deming

WALTER FENN DEMING, prominent in the civic life of Salem, O., and president of the Deming Co. of that city, died of heart failure at his home on March 19.

WALTER FENN DEMING

Mr. Deming's life was interwoven with the welfare of Salem, where he was born in August, 1853, and where he had always lived. He had served actively on the board of education, as trustee of the public library, and as president of the city hospital, the creation of which was due largely to his work and enthusiasm.

His professional life was devoted to manufacturing of power machinery and pumps, first as secretary and general manager of the Silver & Deming Co., which was founded in 1854. Mr. Deming went with them in 1874, and six years after they began the manufacture of pumps, which was carried on until 1890, when the Deming Co. took over the pump industry, W. F. Deming becoming treasurer. In 1894, on the death of his father, John Deming, Walter Deming became president of the Deming Co., which position he has since held.

He was also a director and vice-president of the Farmers National Bank, and was active in all movements for the upbuilding of Salem. The esteem in which he was held is indicated by the city-wide tribute of suspending all activities in all plants for five minutes during his funeral as a tribute to his memory.

Mrs. Deming and two children, G. R. Deming, assistant secretary and treasurer of the company, and Mrs. Albert R. Silver, survive him.

Block Plant Discussed by Chief Engineers

SPEAKING at a luncheon given by the Chief Engineers' Association of Chicago on March 24, Dr. E. Vernon Hill of the Chicago City Sanitary Department pointed out the health significance of the block plant system of furnishing heat, light and power to the business and thickly populated residential district of the city as has been advocated by the association. As a doctor he would rate the degree of civilization of a race, country, community or city in accordance with the state of cleanliness in their homes, streets and industries. The advancement of civilization is dependent upon the protection of the health of the human race from diseases which are carried by the things with which we come in contact, such as the ground, water and food, and air. While such diseases as the bubonic plague, cholera, typhoid fever and the like for some time have been and are still on the decrease, those due to foul air, commonly known as pulmonary diseases, are on the increase rather than the decrease, due to the growing density of population, accompanied by growing industries and traffic that pollute the air with dust and soot. In Chicago alone, the number of deaths due to pulmonary diseases amounts to 10,000 annually.

The power plant engineer's part in the fight to clean the air of the city is the prevention of smoke from boiler furnaces, and eliminating flying dust from coal and ashes, and Dr. Hill pointed out that the methods now employed by the smoke inspection department are not, according to his way of thinking, entirely correct. In addition to the control of furnace design in new plants and the fining of individuals who violate the smoke ordinance, a definite plan should be mapped out establishing district or block heating or heating and lighting plants, as the survey of the district indicated to be the most feasible of solution. Such plants would do away with dust due to handling coal and ashes in the basements of apartments, they could be operated without producing smoke which cannot be done satisfactorily with a small heating plant such as ordinarily used in such buildings, and by increasing the size the plant can be made more economical in the use of fuel. As another means of reducing the smoke in the city atmosphere he advocates the construction and operation of a municipal gas coke plant which would produce gas for lighting and cooking and smokeless coke for heating purposes.

He estimates that at the present time there are 10 to 15 boiler plants in each block of the downtown district of the city comprising about 56 blocks, each one of which with proper planning and co-operation could be served by one plant thus reducing the chimneys from 560 to 56, and these plants could be watched more closely and operated more efficiently.

Joseph Harrington spoke of the engineering phases of the block-plant scheme for furnishing the city with heat and light. One of the deciding factors in the efficient combustion of fuel, he pointed out, is the rate at which it is burned. This must be maintained high enough so that the heating surface will get the benefit of the radiant heat generated in the fuel bed. It was his suggestion that plants should be combined to the point where the combustion rate can be maintained properly. In working out the plans, he cautioned against assuming that the largest plant within the district is the most logical plant to handle the load, for it must be properly designed, equipped and operated for the conditions to be met or the results will not prove satisfactory. As a general rule, it may be considered that efficient combustion is smokeless combustion, so that when you stop smoke and maintain a high rate of combustion, you save coal.

It has been thoroughly demonstrated that where all the exhaust steam from the generating units can be used for heating purposes, the isolated electric lighting plant is more economical than the central station; but before a block plant has been decided upon, an engineering survey of the needs of the block must be made. In the business district of the city, he is of the opinion that the problem, with careful planning and by continuously keeping the idea before the building owners, will be worked out gradually as new buildings are built. For the success of the block plant, the features must be founded upon sound engineering principles which have been proven correct by modern practice.

News Notes

A MOVEMENT is now in process of organization to combine into one organization representatives of all engineer associations of the city of Chicago and vicinity for the common welfare of all their members through legislative action, mutual assistance, or other necessary means, and in order to get this assistance all operating engineers should become members of some engineering organization. The attention of all engineers who are not now members of the N. A. S. E. is being called to the organization so that when the proper time arrives they may expect and receive the protection which will be offered them by the Chicago Operating Engineers Clearing Association.

BY A SPECIAL arrangement entered into by Dr. Bain, director of the Bureau of Mines, with the officials of the Canadian Bureau of Mines, these national agencies will exchange all available information on lignite research work that they have been doing and will, in the future, carry on this research jointly. This is aimed to secure more valuable results and prevent duplication of effort and expense. W. W. Odell, of the U. S. Bureau of Mines, has been sent to Canada to make a detailed study and watch investigations. A Canadian engineer will be sent to Washington for the same purpose in the near future.

AMERICAN TRADE ROUTES to foreign markets is to be the subject of study by a special committee of the Department of Commerce. The secretary explains that the study will cover shipping board operations and would show how far the Government should go in the maintenance of established trade routes. It will cover also the question of rail and terminal facilities, ports and harbors, both Government controlled and private steamship lines and the application of the preferential rail rate section of the Merchant Marine Act. This is to become part of a more definite reconstruction program which it is planned to outline.

THE CONVEYORS CORPORATION of America announces the appointment of Robert B. M. Wilson as sales engineer of the Chicago district. With him will be associated as an assistant, E. M. Wolfe. Headquarters will be maintained in the Corporation's main office at 326 West Madison St.

THE MERKLE MACHINERY CO., 1733 Walnut St., Kansas City, Mo., has been appointed western selling agency for the Under-Feed Stoker Co. of America. This agency has branches in Omaha, Neb., at 621 Securities Building, and in Tulsa, Okla., at 209 Seaman Building. M. L. Alison, 616 Newhouse Building, has been appointed to the Salt Lake City territory. A new southern agency is announced in Dallas, Texas. The Under-Feed Stoker Co., will be represented there by Smith & Whitney, Southwestern Life Building.

THE APPOINTMENT of J. B. Crane to the sales and engineering department of the George T. Ladd Co. has just been announced. Mr. Crane has had over 15 yr. experience in the construction and operation of power houses and has a wide acquaintance among the public utilities, engineers and mining men in various parts of the country.

THE HOOVEN, OWENS, RENTSCHLER CO. announces that F. H. Boyer, Hubbell Building, Des Moines, Iowa, has been appointed one of the agents in the Des Moines district.

HOMESTEAD VALVE MANUFACTURING CO., INC., announces that on April 1, 1921, E. E. Jones took charge of its New York office at 242 Lafayette St., New York City.

CONSTRUCTION of the new power plant for the Altoona, Pa., school district will be started early in April, according to present plans of the Altoona board of education.

THE NEW YORK STATE public service commission, second district, has approved construction by the Depew & Lancaster Light, Power and Conduit Co. of an electric lighting and power plant in Colden township, Erie county, for furnishing and transmitting electricity. The commission also approved exercise by the company of a franchise granted by the town of Colden on Nov. 13 last. The commission holds that the construction is necessary and convenient for the public service.

ENTAILING a property loss of machinery and building that will total easily $200,000, fire on March 13 completely destroyed the electric power plant of the Hudson Coal Co.; located close to the Coalbrook breaker. in Carbondale, Pa. The origin of the fire is not known. The power plant furnished electric power to Coalbrook, Wilson Creek, Powderly and No. 1 collieries in Carbondale; Clinton colliery, Vandling, and the Jermyn breaker. The plant has been completed about two years, and the most modern equipment in the development of electric power was installed. As a result of the fire some 3000 men were thrown out of work temporarily.

Trade News

A COOLING COIL that is different has just been placed on the market by the Steere Engineering Co. Several structural features are worthy of note. The design is similar to that of the water-tube boiler insofar as the construction is concerned. The standard bank is 26 tubes high, 20 ft. long made of 2-in. boiler tubes expanded into steel headers. Division plates are welded into the header between every pair of tubes, thus putting all tubes in series. A triangular water distributing trough, made of No. 12 gage steel, is located on top. The bottom edge is notched to distribute the water as evenly as possible over the pipes. The tubes are so spaced as to leave a ¾-in. opening between them; this is less than the usual amount, and tends to reduce loss from side winds. Due to this feature, wind strips are unnecessary and freer circulation air through the stack results. All parts are electrically coated with zinc, inside and out, after assembly of the unit so that no iron surface is exposed to the deteriorating action of hard water. Opposite each tube in the header is a handhole through which the inside of the piping is readily accessible for cleaning.

IN ORDER to overcome the detrimental effect of a low power factor for comparatively small loads, the General Electric Co. has developed a stationary or static type of condenser, which is described in Bulletin No. 49,714C, "Static Condensers," superseding Bulletin No. 49,714B. The bulletin points out that the static condenser is an extremely efficient device. The losses in the 2300-v. equipments are only ½ per cent of the rated kv.a. capacity. The losses in the low voltage equipments are increased to 3 per cent, due to the auto transformers.

A number of curve charts, diagrams of connections, drawings and tables on prices, dimensions, losses and weights in the case of condensers, circuit breakers and transformers are provided. The bulletin is well illustrated and includes a number of photographs of actual installations.

METALLIC PACKING is the name of a 62-page book recently issued by the Crane Packing Co. This book takes up the development and the correct use and application of metallic packing to modern equipment.

The book, while essentially a catalog of the Crane Packing Co.'s product, is also intended to assist the operating engineer more fully to understand packing problems, and to point out the way by which packing troubles may be permanently overcome.

The author, J. M. Walton, is an authority on the subject and his book contains much information for the practical as well as the designing engineer.

The first three chapters are devoted to the fundamental theory and principles which underlie the operation of all successful packings. There is a chapter devoted to a discussion of the proper dimensions for stuffing-boxes, which, together with a set of curves appended, will be of value to the engineer who is called upon to design stuffing-boxes of any kind.

The book is bound in cloth and contains numerous illustrations. A fair number of copies are on hand for general distribution.

COMBUSTION ENGINEERING Corporation has recently issued a 16-page pamphlet relative to the River Rouge plant of the Ford Motor Co. The material contained in this pamphlet was delivered before the mechanical section of the Engineering Society of Western Pennsylvania by H. D. Savage and in addition to the description of the powdered coal equipment installed at the Ford plant contains a verbatim report of the discussion which followed the reading of the paper. It is illustrated with diagrams of the boiler plant and with photographs of the powdered coal burning apparatus.

BULLETIN F-70, describing Froude Dynamometers, has recently been issued by the C. H. Wheeler Mfg. Co., the American manufacturer of this machine which was originally brought out by Messrs. Heenan and Froude, of Worcester, England. This booklet discusses in more or less detail the design of the Froude hydraulic absorption dynamometer and its application to various kinds of work from small automobile motors to a 6000-hp. prime mover.

MOTOR SPEEDS as high as 25,000 r.p.m. are now practicable for obtaining increased production and operating efficiency, according to Bulletin No. 41,521A, superseding Bulletin No. 41,521, issued by the General Electric Co. This bulletin, which is entitled "High Speed Induction Motors and Frequency Changers," goes into detailed descriptions of the installation of these motors on various types of machines, showing illustrations in each case.

LILLIE EVAPORATORS for Waste Waters and Solutions Generally, is the subject of Bulletin 114 published by the Wheeler Condenser & Engineering Co., Carteret, N. J., manufacturers of the Lillie evaporators. In it are described in considerable detail the features peculiar to the Lillie evaporator and several installations for sugar work, distilling water, and for evaporating many kinds of chemicals, solutions and waste waters. The solution is forced to the top of the body of an effect and evenly distributed over the outside of the tubes in thin, rapidly moving films. Thus all of the available temperature difference is utilized for causing heat transmission and an unusually high rate of heat transmission is attained. Incrustations are taken care of by periodical reversals of both vapors and liquors through the effects. Those interested in the production of distilled water for boiler make-up feed on shipboard and in power plants will be interested in the description of the Lillie six-effect evaporating plant on the U. S. S. Tennessee and California. A perspective diagram is also given of the triple-effect and auxiliaries recently installed at the power station of the Chile Exploration Co., Tocopilla, Chile.

STORY OF THE FILES STOKER told at a glance, is the title of a folder from The Files Engineering Co., Inc., Baltimore, Md.

THE LATEST catalog discussing principles and operation of the National Stoker, made by the M. A. Hofft Co., Indianapolis, Ind., was lately received.

THE GRISCOM-RUSSELL CO.'S Bulletin No. 315, describing the G-R Multiscreen Filter, a redesign of the Reilly feed water filter and grease extractor, has just been received.